JOURNAL OF THE AMERICAN PEAT SOCIETY

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AMERICAN PEAT SOCIETY
TOLEDO, OHIO

AMERICAN PEAT SOCIETY.

SCOPE AND PURPOSE

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. It is an organization devoted to research and to the dissemination of information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat and muck.

FREE SERVICE TO MEMBERS

The American Peat Society, through its Consulting Committee, consisting of botanists, geologists, chemists, bacteriologists, and engineers of recognized standing, will answer inquiries from members relating to the use of their deposits. There is no charge for general service.

NATURE AND USES OF PEAT AND MUCK

Peat and muck are residues resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas covered or saturated with water. They may be identified as the dark-colored soils found in bogs and swamps and in other low places. The commercial uses of peat and muck are varied. In the United States they are utilized chiefly as crop soils, as soil conditioners, and as ingredients of fertilizers. In some of the countries of Europe peat is used for fuel and is the basis for small manufacturing industries. Gas, charcoal, coke, and some by-products are produced in small quantities. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of litter, packing material and rugs, and selected varieties of peat moss have been used to make surgical dressings.

ECONOMIC ASPECTS OF PEAT

The United States contains over 12,000 square miles of undrained peat and muck land. The average deposit, if used for industrial purposes, will yield 200 tons per acre-foot. It is estimated that the deposits would be capable of yielding about 14 billion short tons of air-dried peat. Peat and muck areas are distributed throughout the Great Lake, Pacific Coast, and Atlantic Coast States. Peat and muck in Canada cover 37,000 square miles. According to published statistics, European countries annually consume about 50 million tons of peat fuel.

MEMBERSHIP

Present membership of the American Peat Society consists largely of agriculturists, engineers, and peat and muck land owners and producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetable matter, and in the production of fuel or generation of power, may join. Applications should be addressed to the secretary. Membership and subscription to the Journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS

Meetings of the Society are held annually in important cities throughout the peat regions. Papers are presented relating to the subjects enumerated. A quarterly journal, containing the proceedings of the Society, papers concerning all phases of peat, muck, and allied subjects and news of the industry, is published and sent to members. The scope of the papers is very broad, including the location of deposits, drainage and reclamation problems, methods of cultivation, fertilizer requirements, crop adaptation, cultural practice, physical and chemical characteristics, engineering practice, and production methods. One of the principal objects of the Society is the exposition of extravagant claims made by promoters.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society.

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(Date)

MR. CHARLES KNAP, *Secretary-Treasurer,*
American Peat Society,
2 Rector St.,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This action is prompted by my interest in the science and utilization of peat and muck and the welfare of the society.

Yours very truly,

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(Signature)

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(Address)

CONTENTS

PAST PRESIDENTS
OF THE AMERICAN PEAT SOCIETY

DR. JOSEPH HYDE PRATT,
State Geologist of North Carolina,
Chapel Hill, N. C.

JOHN N. HOFF,
2 Rector St.,
New York, N. Y.

DR. EUGENE HAANEL,
Director Department of Mines,
Ottawa, Ontario, Canada.

L. B. ARNOLD,
Duluth, Minn.

PROFESSOR PETER CHRISTIANSEN,
Professor of Metallurgy, School of
Mines, University of Minnesota,
Minneapolis, Minn.

PROFESSOR HOMER C. THOMPSON,
In Charge Department of
Vegetable Gardening
Cornell University,
Ithaca, N. Y.

PROFESSOR A. C. WHITSON,
Professor of Soils,
In Charge Agricultural Experiment Station,
Madison, Wis.

MYRON W. ROBINSON
New York, N. Y.

Manuscripts sent for consideration by the editor should be registered. Written discussions of papers are invited. Authors wishing reprints of articles are requested to correspond with the editor. Advertising rates will be furnished upon application to the secretary.

Toledo Type-Setting & Printing Co.
132 Erie St.
Toledo, Ohio

Journal of the
American Peat Society

VOL. XVII. JANUARY, 1924 NO. 1

AMERICAN PEAT SOCIETY STRENGTHENED

No one who attended the seventeenth annual convention of the American Peat Society in Washington, D. C., December 6-8, 1923, or who will read the proceedings of the Executive Committee and of that convention reported in this Journal, can fail to appreciate that the Society has been greatly strengthened and is now in position to render increased practical and scientific service. Strong officers of standing, who have the confidence of all who know them, were elected. The fundamental purpose of the Society at the time of its organization, namely, to carry on research and to disseminate knowledge concerning peat and muck, was reiterated. The intention at all times to expose false promotion and point out extravagant claims and unscientific engineering practice was again affirmed. The hearty co-operation of leading scientists in official Government circles was obtained. A motion was passed to organize a Consulting Committee, consisting of Government and private scientists of standing, who would answer inquiries from members relating to the use of their deposits. There is to be no charge for this general service. Another motion was made and carried, to organize a Board of Councillors, consisting of prominent men, who would lend advice and counsel to the Society. These bodies are now being formed, and their personnel will be announced in the April number of the Journal. Contributions amounting to several hundred dollars each were made by members in order to further the work of the Society and the progress of research.

PROCEEDINGS OF EXECUTIVE COMMITTEE

The annual meeting of the Executive Committee of the American Peat Society, preceding the Seventeenth Annual Convention, was called to order at 9:30 A. M., December 6, 1923, in the Spanish Room of the Hotel Washington, Washington, D. C., by J. N. Hoff, Chairman.

Mr. Hoff. Good friends and members of the American Peat Society, it is a great privilege to greet you, to extend a hearty welcome, and to congratulate you on being present.

The American Peat Society was organized at the National Exposition at Jamestown, Virginia, on October 23, 1907, and was incorporated under the laws of the State of New York in 1912.

Its purpose is to discover and disseminate information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and the uses of peat and muck and to stimulate interest in the science and use of the widely distributed deposits of the substances in North America; in other words, to encourage the economic use of our peat deposits in every practicable way in industry and agriculture.

The field, as can be seen, is broad and varied, giving free play to the geologist, botanist, biogolist, chemist, and to the engineer specializing in fuel, drainage or mechanics, *and last, but most numerous and and important, the farmer and market gardener*, who elect to grow their crops in humus soil.

Professor Davis, the founder of our Society, pointed out to me many times during our botanical and peat bog excursions, that those interested in the use of peat in the fuel and related industries were so few as to woefully limit our membership in that field. He added however, that in the agricultural branch there was an opportunity for large membership and wide interest in peat and muck.

I am sure Professor Beattie and our friends in the Agricultural Department will agree, and therefore it is along these lines that cooperation must be sought and membership increased.

In Europe, where coal is not so well distributed, and peat is plentiful, fuel and allied uses for peat are of popular interest. In

the United States, where coal is so abundant and well distributed geographically, it stands to reason that a product with one half to two-thirds the fuel value of coal, and which requires de-watering before it can be availed of, is of interest as fuel only in a limited way and in places remote from the coal fields.

We must, therefore, look to students of agriculture and of the adaptability of peat as a fertilizer ingredient, or to the extraction of sulphate of ammonia for fertilizer use, to give this society members and funds for further growth.

From the foregoing, it will be seen that we must seek agricultural members, and must ask financial aid from those interested in the production of fertilizer ingredients from peat.

Furthermore, co-operation and financial assistance should be sought from the Government.

The Society is purely scientific in scope and purpose. It is for the welfare, advancement, and development of a great national and natural resource, the magnitude of which has never yet been fully realized.

Following Mr. Hoff, Mr. J. H. Beattie made the following remarks in substance:

MR. J. H. BEATTIE. Before the Executive Committee proceeds with the consideration of business matters, I should like to call its attention to a misunderstanding concerning the objects of this Society that seems to exist in some quarters, and to suggest that action be taken which will permanently place the Society on record before the public. There is a feeling on the part of certain persons that the policies of the Society have been influenced by promotion. Personally, from many years' connection with the organization, I am sure that this feeling is entirely unfounded. The membership consists almost exclusively of persons interested in the advancement of peat and muck science and in the encouragement of the correct economic use of our vast deposits in agriculture and industry along rational lines. The misunderstanding, however, is a serious one and I believe has been somewhat of a handicap to the Society. I am calling it to the attention of the Executive Committee for consideration at this time.

MR. OSBORN. Mr. Chairman, I, too, have sensed the feeling which Mr. Beattie has so clearly pointed out, but, like him, I am con-

vinced that it is entirely unfounded. In order to place the Society on record, I offer the following resolution for action by this Committee:

> "Whereas it has been suggested that a misunderstanding exists in some quarters as to the policy and object of the American Peat Society, be it resolved that this Executive Committee, duly authorized by the Society to act on its behalf, hereby declares the American Peat Society to be an organization devoted to practical-scientific research and to the dissemination of information concerning the economic utilization of American muck and peat deposits."

The resolution was adopted unanimously.

MR. OSBORN. Mr. Chairman, the Secretary-Treasury has asked me to call attention in his behalf to the last financial report of the Society published on page 138 of the October, 1923, Journal. I shall not take the time of the Committee to read that report in detail. I shall, however, draw some conclusions of much concern from that report and from a knowledge of certain expenses that the Society must meet in order to continue the publication of the Journal. The outstanding feature of the statement referred to is the unpaid subscriptions amounting to $265. Unfortunately, many members have been very delinquent in the payment of their annual dues, and some financing must be done to continue the work of the Society. Whereas our annual income in past years has exceeded $1,200, the proceeds from memberships in 1923 amounted to only a little over $800. Expenses during the same period exceeded $1,000. In consequence, the size of the Journal has unfortunately been necessarily reduced and the work of the Society hampered.

Several weeks ago I wrote to Dr. Hernfrid Witte, Director of the Swedish Peat Society, for a statement from him of the nature of their work and of their method of financing. His answer, which I have here and shall read to the Committee, is, to my mind, a story of great work well done. To me it is a most interesting report, and I believe it should be an example and a source of great inspiration to the American Peat Society. The report follows:

THE SWEDISH PEAT SOCIETY AND ITS WORK IN PEAT LAND RECLAMATION, WITH SOME SUGGESTIONS FOR SUCH WORK IN UNITED STATES

By Dr. Hernfrid Witte, Director

The reclamation of peat land or the utilization of peat soils for cultivation has during the last decades been of much importance in many European countries—notably Sweden, Norway, Finland, Germany, Austria, Holland and Ireland. The greater the growth of mineral soil cultivation the more pressing this reclamation problem becomes. However, the cultivation of peat soils is more complicated and requires a more intimate knowledge of the character and the treatment of the soil than that of ordinary mineral soils; if such knowledge is not available the result will usually be a failure. In many European countries institutions have been established with the aim to investigate all questions regarding the cultivation of peat soils and to give the farmers information as to how they should cultivate such soils. Given the opportunity to say how such an institution ought to be organized, it seems to me most appropriate to describe our Swedish organization for peat land reclamation, formed through experience gained during nearly four decades.

Sweden has vast areas of bogs or peat land. According to investigations made during the recent years, the peat land area is calculated for South and Central Sweden to 8.4 per cent and for North Sweden about 30 per cent of the total area. To a great extent, the Swedish bogs can be cultivated and that is especially the case in northern Sweden, where at present the bogs represent the most valuable and arable soil, and where the further development of agriculture depends upon the utilization of the bogs.

The interest in bog cultivation is old in Sweden and during the 19th century great areas have been cultivated. It was, however, necessary to form an organization that could make careful investigations of all the circumstances connected with the cultivation of peat soils of different kinds. For that reason, the Swedish Peat Society was founded in 1886 and it has from a very small beginning developed its sphere of action to its present position—the official organization for peat soil cultivation.

The aim of our Society is:

(1) To carry out at its laboratories and experimental garden and at its experimental farms carefully arranged investigations and experiments regarding cultivation of peat soils;

(2) To take up in its botanical and chemical laboratories scientific investigations that may lead to increased and enlarged knowledge of peat soils and their utilization;

(3) To publish a periodical treating questions connected with the utilization of peat land for different purposes;

(4) To give the farmers advice and information about the proper utilization and the most appropriate treatment of their soils;

(5) To disseminate information about the utilization of peat land through lectures, lessons, pamphlets, meetings, illustration fields and through other suitable means.

For the maintenance of its work, the Society receives subvention from the Government, and grants from agricultural societies and county councils. The total sum of these grants is at present about 100,000 Sw. crowns.

The Society has its headquarters in the town of Jonkoping, where it operates an institute with botanical and chemical laboratories, library, museum and offices for the director and the officials. At the institute there is an experimental garden, where pot and plot tests are conducted. Further, the society operates two experimental farms, one in South and one in North Sweden; each of these farms has a cultivated area of about 100 and a total area of about 250 acres.

The staff of officials consists at present of one botanist and peat geologist, two chemists, one assistant at the experimental garden, three consulting engineers, two superintendents for the experimental farms, one cashier, two correspondents and one caretaker.

Now I will give a short review of the work of the Society, which may be divided into three different branches; practical-scientific, consulting, and informing.

The practical-scientific work, aiming to increase the knowledge of

peat soil, its characteristics and its proper use for cultivation or for technical purposes, consists of field investigations of peat land, chemical analyses and different kinds of culture experiments.

The field investigation of bogs are made by the botanist of the Society and includes a research of the composition of recent vegetation and the geological construction.

The analytical work, which is made in the chemical and botanical laboratories is intended first to determine by way of chemical analyses the proportions of different plant foodstuffs in peat soils, their capacity for absorbing fluids, and their fuel value; second to ascertain by botanic-microscopic investigations the degree of decay of the peat and its origin. On basis of such analyses the owners of peat land receive reports, indicating the proper use of the peat soil, of which they have sent samples. Up to 1922, there were made in the chemical laboratory analyses of 8,058 samples of peat soil for agricultural reclamation, 3,280 of peat fuel and 1,762 samples of moss-litter, as well as many analyses of manure, lime, hay, grain and other products from the field experiments. In the botanical laboratory up to 1922: 15,485 microscopic analyses of peat soil, 14,677 germination tests and other tests of seeds from the experimental farms and field, and 4,688 quantitative botanical analyses of hay were made.

The culture experiments, a most important branch of the work of the Society, relate to the investigation of all questions regarding cultivation of peat soils under different climatic and other conditions. Those experiments are conducted as pot and plot tests in the experimental garden and as field tests at the experimental farms of the Society.

Local tests, illustration field, and model pastures are arranged even on private peat soils of different kinds in several parts of the country.

The consulting work, which is very extensive, is carried on by three consulting engineers, each of whom has his special district of the country. These engineers visit the farmers upon request, investigate their peat bogs, and give advice and information as to the value of the bogs for reclamation and for technical purposes. In 1922 the engineers investigated a total area of 13,751 acres of peat land, of which 11,539 acres were suitable for reclamation or already cultivat-

ed, 1,272 were suitable for peat fuel, and 227 for the production of moss litter.

The informing work is carried on to make the public acquainted with the work of the Society as well as with other experiments within the sphere of peat land reclamation, peat soil cultivation and the peat industry generally. The information is published in the following ways:

(1) By the Journal of the Peat Society, which has appeared since 1887 with 6 numbers yearly;

(2) By distributing circulars and leaflets regarding the more important questions of peat reclamation, peat soil cultivation or the peat industry;

(3) By lectures given by the consulting engineers; in 1922 the officials of the Society gave about 140 lectures in different parts of the country;

(4) By courses in peat land reclamation and peat soil cultivation given once a year at the experimental farms. These two day courses are attended by 200 to 300 farmers from various parts of the country;

(5) By meetings with lectures, discussions and excursions twice or three times yearly at different places;

(6) By exhibitions at agricultural shows;

(7) By illustration fields, demonstrated in the summer by the consulting engineers.

Among the popular publications, which have been distributed in great numbers by the Society to the farmers, the following are outstanding: "Some practical experience in peat soil cultivation gained by 23 years of experimental work;" "Short notes on peat soil culture;" "Phosphate manure and its importance in plant culture on peat soils;" "Artificial pastures on peat land;" "Potato-culture on peat soils;" and "Moss litter and its importance in agriculture."

The work of the Swedish Peat Society is of great importance for agriculture in Sweden and is followed with great interest by the Swedish farmers, who visit the experimental farms and fields of the Society in large numbers and request the location of projects for plant culture on their peat soils. During the last 40 years a con-

siderable area of bogs—about 1 million acres—has been cultivated in Sweden.

I have tried to give a short general survey of our Swedish organization for the rational utilization of our bogs for agricultural purposes. I will now try to give you some suggestions for such an organization in United States, but in doing that, I must lay stress upon the fact that I do not have sufficient knowledge of American conditions properly to discuss the matter.

I assume that a central organization as ours is required in the United States. The vast areas of bogs in Minnesota, Wisconsin, Michigan, the New England States, etc., give rise to the belief, that it is necessary for your country to carry on experimental work on peat soils. Experience gained in Europe may not be directly applicable to your conditions. Each State I understand, has an agricultural experiment station, but I don't believe this is proper. On the other hand I consider that there should be one single institution, which has its own experiment stations and which can arrange uniform plans for tests under different conditions of soil and climate. Such an organization is more firm, much more specialized and therefore better adapted to give reliable information and advice regarding the treatment of peat soil than the many different experiment stations.

I believe that the American Peat Society with subsidence from the Government and from the States, is best qualified to organize such work.

At first, the Society should buy an uncultivated bog of good quality and with an area of 300 to 400 acres (if possible with 30 to 40 acres of sandy soil in the neighborhood). This bog, should be situated close to a railway station, (say in Michigan or Wisconsin) should be drained, partly cultivated, and arranged as an experimental farm with tests of the following different kinds: draining tests with different distances between the drains and different depths of the drains; manuring and liming tests; rotation tests, tests with soil improvers as sand and clay; tests with different strains of the more important crops, etc. It seems to me that they should build an institute with laboratories, etc. at the same place, so that the officials will be closely connected with the practice, which is of importance in their information work. From these headquarters local tests could be arranged on

bogs of different kinds and in different parts of the country, and if it seems necessary, additional experimental farms should be established in places where they are required. I think it would be best to begin with one experimental farm close to the main institute and then gradually upon demand from the farmers extend the operations. I thank you.

MR. OSBORN. Mr. Chairman, it seems to me that there are many lessons to be gained from Dr. Witte's discussion, but to me the outstanding one is this. If the American Peat Society is to grow it must do so on the basis of service to members. I am going to ask this Committee and the membership to do some financing, but we must first strengthen our Society so as to give more in return for what we need and hope to get. My plan contemplates the formation of a Consulting Committee consisting of botanists, geologists, horticulturists, engineers, and chemists, members of the Society, who will be willing to volunteer their services, at least at the start. It will be the duty of this committee to answer the inquiries of owners of peat land and others, free of charge, and, as far as possible, to give advice as to the uses of peat and muck deposits. The only requirement from the inquirer would be membership in the Society. The headquarters of this body, I think, should be located in Washington, where central meetings might be held. The remainder could function by correspondence and regional group meetings. This committee should immediately meet in Washington and invite the agricultural experiment stations in the peat and muck States to send representatives to a general conference for the purpose of getting together and eliminating duplication of work and conflict of opinions, as well as advancing peat and muck land research in general. I can see wonderful possibilities in this plan if it is carried out. The result might co-ordinate national peat and muck research and make the American Peat Society, and this Committee particularly, the clearing house for agricultural and industrial research work in the United States on these subjects. I should be glad to serve personally, and I will furnish all the data I possess on the geology and economics of peat and muck in the United States. The successful use of peat deposits agriculturally rests upon intensive cultivation, and this in turn upon a proper knowledge of crop adaptation.

There was a reason for holding this meeting in Washington, D.

C. It is the center of agricultural and industrial research. There is great need for research in peat and muck, not only in the interest of the proper utilization of the present deposits, but also for the light the results might throw upon other problems. The value of peat and muck as crop soils has been demonstrated. They are valuable as a soil conditioner. There are two schools of thought concerning the value of peat and muck as a fertilizer ingredient, and both are able to present evidence that is worthy of consideration. Peat may be used in some places where low-grade fuel will suffice. This is particularly true of Central Canada and in certain areas of the United States far removed from the coal fields. What peat and muck need is sympathetic, co-operative research. This meeting is an attempt to bring scientists together for the purpose of round-table discussion, and I hope the outcome will be the formation of the committee I suggest.

Now, in order to give, the Society must also take. Five dollars a year from each member as dues will not support the work I have outlined. We must have sustaining members, that is, contributions from members who are financially interested in peat and muck and who would be willing to advance the knowledge of the subject by furnishing funds for research purposes. I would call the body I suggest a Board of Councillors. Personally I haven't a dollar invested in any peat property, but I will make a beginning by contributing $200. I should like to see the Society take action on my proposal for the formation of a Consulting Committee and a Board of Councillors.

Mr. Hoff. I will subscribe an additional $200.

Mr. Steenburg. I will give $200.

Mr. Hoff. Is there further discussion of these questions?

Mr. Haanel. I think the suggestions made are excellent, and I will subscribe $1,000 in good will for the American Peat Society. I am a member of the Bureau of Mines of the Canadian Government, and am sorry that I can not do more. The Swedish Peat Society is subsidized by the Government, and the members are, therefore, getting benefit from membership much in excess of the membership fees.

The proposal was adopted unanimously and Mr. Osborn was made Chairman of a Committee for the formation of the two bodies.

The suggestion was made that a Government appropriation might be obtained. It was stated that this would be attended by great difficulty, but it seemed to be the general feeling that if the matter were properly presented and the possibilities of the undeveloped peat and muck areas were properly outlined, action might be obtained. However, no official action was taken by the Society on this proposal.

A committee on nominations, consisting of Messrs. Haanel, Steenburg, and Osborn, was then appointed and the Executive Committee adjourned.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION

The Seventeenth Annual Convention of the American Peat Society was called to order at 2:00 P. M., December 6, 1923. Mr. W. R. Beattie, Horticulturist of the United States Department of Agriculture, presided. The following papers were presented and discussed:

"Economic Factors Involved in the Production and Marketing of Muck Crops"—Dr. L. C. Corbett, Horticulturist in Charge of Horticultural Investigations Bureau of Plant Industry, United States Department of Agriculture.

"Financial Side of Muck Land Development"—W. C. Steenburg, South Bend, Indiana, Owner and Operator of Several Thousand Acres of Muck Land in Indiana and Wisconsin.

"Peat Developments in Minnesota in 1923"—F. A. Wildes.

"A Roller for Peat Soils"—Colonel John T. Stewart, Consulting Engineer, St. Paul, Minnesota.

Mr. B. F. Haanel, of the Canada Department of Mines, briefly reviewed the progress of peat fuel experimental work in the past several years and pointed out many of the things that could and could not be done in peat fuel manufacture.

Several of the papers presented during the Seventeenth Annual Convention appear in this edition of the Journal, and the remainder will be published in succeeding editions.

The following is an incomplete list of the persons who attended the sessions of the convention:

H. R. Smalley,
702 Insurance Building,
Washington, D. C.

A. G. McCall
College Park, Indiana

N. R. Smith,
Soil Bacteriologist Department of Agriculture,
Washington, D. C.

R. C. Wright,
United States Department of Agriculture,
Washington, D. C.

David White,
United States Geological Survey,
Washington, D. C.

Robert Ranson,
St. Augustine, Florida

Thomas F. Manns,
University of Delaware,
Newark, Delaware.

T. H. Riggs Miller,
Flushing, N. Y.

C. C. Fletcher,
Bureau of Soils,
Washington, D. C.

George S. Brewer,
Bureau of Mines,
Washington, D. C.

B. F. Haanel,
Department of Mines,
Ottawa, Ont., Canada.

W. C. Pelton,
University of Delaware,
Newark, Del.

E. O. Fippin,
404 Evening Star Building,
Washington, D. C.

Dr. L. C. Corbett,
United States Department Agriculture,
Washington, D. C.

Miss K. W. Cottrell,
United States Geological Survey,
Washington, D. C.

C. M. Litteljohn,
Representative of Florists Review,
Chicago, Ill.

George F. Kleinberger,
311 West 97th Street,
New York City

Chester A. Garner,
United States Department of Agriculture,
Washington, D. C.

John N. Hoff,
2 Rector Street,
New York City

W. R. Beattie,
United States Department of Agriculture,
Washington, D. C.

C. C. Osborn,
Ponca City, Okla.

J. H. Beattie,
United States Department of Agriculture,
Washington, D. C.

J. E. Lapham,
Bureau of Soils,
Washington, D. C.

D. N. Shoemaker,
Washington, D. C.

J. G. Smith
Bureau of Soils, Department of Agriculture,
Washington, D. C.

A. T. Sweet,
Bureau of Soils,
Washington, D. C.

G. P. Walton,
Fertilizer Division, Bureau of Soils, United States Department of Agriculture,
Washington, D. C.

Franklin W. Marsh,
Department of Agriculture,
Washington, D. C.

W. C. Steenburg,
228 South Main Street,
South Bend, Indiana

Miss Sophy Linker,
Brooklyn, N. Y.

R. F. Gardiner,
Bureau of Soils,
Washington, D. C.

Cornelius G. Weber,
American Appraisal Co.,
Milwaukee, Wis.

G. A. Russell,
United States Department of Agriculture,
Washington, D. C.

Lewis T. Leonard,
United States Department of Agriculture,
Washington, D. C.

C. G. Woodbury,
National Canners Association,
1739 H. Street, North West,
Washington, D. C.

H. A. Huston,
81 Fulton Street,
New York, N. Y.

O. P. Hood,
United States Bureau of Mines,
Washington, D. C.

Dr. G. H. Earp-Thomas,
The Earp-Laboratories,
111 East 34th Street,
New York, N. Y.

Frederick V. Coville,
Bureau of Plant Industry,
Washington, D. C.

A. S. Dick,
B-D-L Corporation,
Fredonia, N. Y.

A. P. Dachnowski,
Bureau of Plant Industry,
Washington, D. C.

C. P. Close,
United States Department of Agriculture,
Washington, D. C.

F. L. Nurlford,
Washington, D. C.

A. H. Redfield,
United States Geological Survey,
Washington, D. C.

During the morning of December 7 the following papers were presented. Mr. J. H. Beattie, Horticulturist of the Bureau of Plant Industry, United States Department of Agriculture, presided.

"The Adaptability and Use of Humus for Turf Production" (Illustrated) T. H. Riggs-Miller, Flushing, Long Island, New York.

"Some Factors Affecting the Storage of Vegetables"—R. C. Wright, Physiologist, Bureau of Plant Industry, United States Department of Agriculture.

"Celery and other Truck Crops Adapted to Muck Soils"—J. N. Hoff, President of Alphano Humus Company, New York, N. Y.

The annual luncheon was held in the grill of the Hotel Washington.

The following papers were presented during the afternoon of December 7:

"Bacterized Peat, Its Possibilities and Limitations"—Dr. Thomas F. Manns, Plant Pathologist, University of Delaware, Newark, Delaware.

"Recent Progress in the Commercial Development of Bacterized Peat"—Dr. G. H. Earp-Thomas, Earp-Thomas Laboratories, Incorporated, New York City.

"The Everglades and other Peat Lands in Florida"—Robert Ranson, West Palm Beach, Florida.

In the convention room there was an exhibit of implements used in cultivating muck soils.

In the evening of December 7, Mr. C. A. Bacon, Research Division, Oliver Chilled Plow Works, South Bend, Indiana, gave an illustrated discussion of the implements for breaking and handling muck and other marsh soils. This meeting was held in the moving-picture room of the Department of Agriculture. Several films, in which various agricultural problems were presented in an interesting manner, were exhibited to members by the Department.

On Saturday morning, December 8, the following papers were presented. C. C. Osborn presided.

"The Agricultural Use of Acid Peats" (Illustrated)—Dr. Frederick V. Coville, Botanist of United States Department of Agriculture.

In this paper Dr. Coville pointed out the fundamental difference between acid and non-acid peats and their significance in plant growth. Dr. Coville also demonstrated a modern method of determining acidity by simple color tests in the field.

"The Production of Crops on Alkaline or Neutral Muck Soils"—W. R. Beattie, Horticulturist of the United States Department of Agriculture.

"Relation of Peat to Oil Shale" (Illustrated)—S. Linker, Brooklyn, N. Y.

The following papers were presented during the afternoon:

"Some Needed Peat Investigations" (Informal discussion)—Dr. David White, Senior Geologist, United States Geological Survey.

In this paper Dr. White pointed out some of the possibilities of peat for crop production, fertilizer, surgical dressings, and other purposes, and suggested some investigations that might throw light upon coal genesis problems, characteristics of peat soils, and the geologic age of formations. It is hoped to present Dr. White's discussion in a future number of the Journal.

"Peat Investigations of the Bureau of Mines" (Informal discussion)—O. P. Hood, Chief Mechanical Engineer, United States Bureau of Mines.

Mr. Hood explained briefly the work that has been done on lignite and the proposed investigation of peat projects and methods in the United States. Mr. Hood's paper appears in this Journal.

"Peat Land and Peat Utilization in the Netherlands"—Arthur H. Redfield, Mineral Geographer of the United States Geological Survey.

Mr. Redfield was formerly Trade Commissioner of the Department of Commerce at The Hague. This paper will appear in full at a later date.

At the conclusion of Mr. Redfield's paper, Mr. B. F. Haanel, Chairman of the Committee on Nominations, presented a report which resulted in the unanimous election of the following officers for 1924:

President—Frederick V. Coville, U. S. Dept. of Agriculture, Washington, D. C.

First Vice-President—J. H. Beattie, U. S. Department of Agriculture, Washington, D. C.

Second Vice-President—W. C. Steenburg, 228 South Main Street, South Bend, Indiana.

Secretary-Treasurer—Charles Knap, New York, N. Y.

Executive Committee

J. N. Hoff,—Chairman, New York, N. Y.

B. F. Haanel, Canada Department of Mines, Ottawa, Ontario, Canada.

Ernest V. Moore, Montreal, Quebec, Canada.

C. C. Osborn—Editor, Journal of the American Peat Society, Box 1173, Ponca City, Oklahoma.

W. R. Beattie, U. S. Dept. of Agriculture, Washington, D. C.

Mr. Haanel also offered a motion, which was seconded and unanimously carried, authorizing the Executive Committee to select the Board of Councillors suggested by Mr. Osborn at the business meeting preceding the convention.

Special mention was made by Mr. Haanel of Robert Ranson, of West Palm Beach, Florida. He said that he had been asked by the Nominating Committee to offer a motion that Mr. Ranson, in consideration for his long continued efforts in behalf of the Society, be made an honorary member for life. The motion was carried.

At the conclusion of the final business session the convention adjourned sine die.

GREENHOUSE CROPS ADAPTED TO ALKALINE OR NEUTRAL MUCK SOILS[1]

J. H. BEATTIE,

U. S. Department of Agriculture

While the forcing structure in its elemental forms dates back for thousands of years, Roman history containing references to the use of hot water heated hotbeds used for the production of winter or out of natural season delicacies, the modern greenhouse is a recent development. The houses and equipment used by the pioneers in the industry were comparatively small, and equipped in a very different manner from the modern structures found throughout our large greenhouse centers of today. Houses of a generation ago were narrow, and usually not over a hundred to two hundred feet in length, as the heating systems in common use were not adapted to the uniform heating of houses of great length. Benches were almost invariably used not only for the handling of potted plants, but for the growing of those products produced in beds of soil. These benches seldom carried more than a few inches in soil and no great volume of earth was required for filling the beds of a house of the size and with the equipment of most structures. The securing of a sufficient volume of good soil for the needs of the average greenhouse operator was a simple matter as an abundance of good stable manure was available and could be secured from the large stables found in all large cities. As a rule this manure could be had at nominal cost, often for the mere hauling. The manure available from such sources some twenty-five years ago was of high quality. Straw was almost invariably used for the bedding of the animals, and the use of chemicals in the manure to prevent the breeding of flies was practiced only in rare cases. Statistics show that the number of horses kept in our cities is rapidly decreasing. The supplies of manure formerly available from sources open to the truck gardener, the market gardener, and the greenhouse operator are now only a fractional part of their former volume. Not only have prices risen to an almost prohibitive point, but in addition to this the

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[1] Prepared for the Seventeenth Annual Convention of the American Peat Society held in Washington, D. C., December 6-8, 1923.

manure now available is of a doubtful value, owing to contamination with such materials as shavings used for bedding material, chemicals used for deodorizing and for fly control, oil from automobiles and from oiled and tarred roads, disintegrated paving material and other materials which, if present in any considerable quantities, are known to be injurious to plant growth. Work carried on several years ago when automobile traffic was only a fraction of its present volume showed that manure swept from the streets of Washington contained as much as two per cent of oil and tarry matter soluble by ether extract. It was shown by actual test on growing plants that this manure was actually harmful to the plants growing on the soil to which it was applied.

Lack of Manure a Problem

The operator of modern greenhouses with structures as much as eighty to eighty-five feet wide, and from six to eight hundred feet long, the total area enclosed frequently amounting to an acre or more, is face to face with a serious problem, as he must have soil well supplied with organic matter and available plant food, for he must make continuous use of every square foot of space enclosed. When we recall that it costs from $20,000 to $50,000 to cover and equip an acre of ground with suitable greenhouse equipment and that it requires from 250 to 500 tons of coal per season to maintain this acre at the temperature necessary for the growing of the delicate crops produced, it becomes evident that intrest charges on the investment and operating expenses are such that the ground must be utilized to its full capacity. According to available statistics the annual gross return from each acre of space enclosed in greenhouses in the United States is close to $20,000 per annum, or almost fifty cents per square foot. Handicapped by not being able to practice soil maintaining crop rotations the greenhouse man faces a serious problem especially since changing conditions have made manure more difficult to secure.

Muck and Peat Promising

The high percentage of undecomposed vegetable matter and the high, though possibly partly unavailable nitrogen content of certain of our muck and peat deposits, suggested these deposits as sources of organic matter and plant food for the production of greenhouse

crops. As early as 1890 work done at the Ohio State University showed that certain kinds of Ohio muck could be used mixed with soil for the growing of greenhouse lettuce. It is believed that this work was among the earliest attempts to utilize the material for the growing of greenhouse crops. In 1911 arrangements were made between the American Peat Society and the Bureau of Plant Industry for the carrying on of cooperative work on the adaptation of muck and peat soils for the growing of greenhouse crops. The work was undertaken at the Arlington Farm, Virginia, under the direction of Professor L. C. Corbett, and Messrs. W. R. Beattie and H. C. Thompson. The actual experimental work carried on during the period from 1912 to 1917 was under the immediate direction of Professor Thompson. The work from 1912 to 1917 involved lettuce, cauliflower, and tomatoes for the first year and lettuce, cauliflower, tomatoes, roses and carnations for the other years. New Jersey muck from the Great Meadows section, Indiana muck from the Kankakee Marsh section, and Michigan muck from the Mentha, Michigan section were included in the experiment. All lots were mixed with sand or clay in varying proportions and compared with ordinary greenhouse soils. Professor Thompson's work was summarized and published in Vol. 14, No. 1, January, 1921, Issue of the Journal of the American Peat Society to which reference is made for a complete discussion of this activity. To summarize this work in a sentence or two, it may be said that it indicated that all three lots of muck showed that the material has great promise for the production of greenhouse crops, it being found that a mixture of one-fourth by volume of the muck to three-fourths by volume of soil gave good results.

Experiments in Progress

During the past few years or since the season of 1917-1918 additional work has been in progress. This work has involved several vegetable and floral crops especially cauliflower, tomatoes, roses and carnations. Only one lot of muck, this from the Kankakee Marsh section, has been used as it was felt that the results secured through the use of this material would give a good indication of what might be expected from the use of the material from other sections, particularly the regions from which the muck used in the earlier work was secured.

The work is still in progress and has not been completely summarized, but a few of the outstanding results may well be given at this time.

Mixtures of one-fourth by volume of muck taken from cultivated fields located on the Kankakee Marsh with three parts by volume of ordinary greenhouse soil made up of well rotted pasture sod and without additional fertilization gave crops of roses, cauliflower and lettuce comparing favorably with those secured from greenhouse soils treated with a heavy application of stable manure. Increasing the proportion of the muck did not materially increase the yield or quality of the crop. Crops secured during a second season without additional soil and with only nominal application of fertilizer were practically equal to those of the first season, but those of the third season were somewhat inferior, there being abundant indications of soil exhaustion. With the conditions under which this work was carried on it would seem that muck should be renewed at least once every two seasons. In practice it is indicated that it might be best to apply some fresh muck every season, although this is only an indication and is not supported by experimental evidence. The work bears out the results secured in the earlier work, and indicates that muck with the characteristics of the material used in this work can be used as a source of organic matter and nitrogenous plant food for greenhouse crops. There was every evidence of the presence of an abundance of available nitrogen in the plots where the mixtures of muck and soil were used, seeming to prove that the nitrogen contained in muck does become available for the use of the crops.

The work performed is of interest and value in showing the possibilities of the material for the growing of certain greenhouse crops. However, the fact that carefully prepared muck taken from the surface of cultivated fields which have been devoted to intensive crops, where the soil has been neutralized where necessary through the application of lime (in the case of the material used in the work outlined above no lime was used as the muck was naturally neutral probably due to the fact that it was underlaid by marl) gives good results, cannot be accepted as proof that all mucks taken from miscellaneous sources without special preparation, and as is often the case dug out by steam shovel methods or pumped out with a dredge, can be expected to give good results. It is probable that much material of this character

would be extremely injurious to the crops to which they are applied. I want to emphasize the fact that muck suitable for greenhouse use must be taken from deposits of uniform character and containing a large percentage of nitrogen, phosphoric acid and potash (the nitrogen being normally present in much larger quantities than the others) and if for the usual greenhouse crops demanding alkaline or neutral soil, it must be of a non-acid character. It must moreover be from areas which have been used for the growing of cultivated crops being ameliorated and conditioned by the action of the sun and air and may have become a congenial home for the growing of tender plants. Material which does not meet these specifications would be worse than useless.

The advisability of using muck or humus for the growth of greenhouse crops must be determined after careful consideration of many factors. The first consideration is to be sure that the material available is capable of giving adequate crop returns. Secondly, it must be secured at a cost which is in relation to the returns given from the applications. In determining the worth of a definite lot of the material for certain crops good business would dictate that it be tried in comparison with other forms of organic matter and after determining its crop return, to find the cost of making the mixture necessary to secure the desired results. In other words apply the same business methods one would use in considering the use of any other similar material.

THE BUREAU OF MINES PEAT INVESTIGATION[1]

O. P. Hood,

Chief Mechanical Engineer

There has been some misunderstanding with regard to the peat investigation authorized by a bill which was approved by Congress February 25, 1919. A brief history of the bill will help to clarify the matter. While the war was in progress, persons interested in the development of lignite urged an appropriation of $100,000 for an investigation which should give information as to the "commercial practicability" of lignite as a source of by-products, with special reference to motor fuel, as at this time there was a prospective shortage in gasoline. A similar bill was introduced by other parties calling for a like sum for an investigation of peat. Opinions were sought as to whether the passage of these bills would help win the war. The Bureau's engineers could not see that the commercial development of peat as a source of either fuel or by-products was sufficiently advanced to become available within the probable duration of the war, but there was a possibility that lignite might play a part. The peat bill was dropped, the lignite bill was amended to include a study of solid fuel as well as by-products, and the words "and peat" were added after the word "lignite." The effect of this amendment was apparently to divide the fund available for a lignite investigation, and inasmuch as this investigation had in its broad outlines been planned, it seemed to seriously endanger the proposed program. After the bill was passed, however, it was pointed out that it did not specify the proportion of funds to be expended on each item. It was, therefore, believed wise to leave the investigation of peat until the investigation of lignite had been completed as near as might be according to the original intent. The original conception of the lignite investigation was that laboratory and small plant experimental work had been conducted to a point where a commercial venture was justified, and that a Government fund should be expended for purely technical direction in co-

[1] Substance of remarks made before Seventeenth Annual Convention of American Peat Society, Washington, D. C., December 6-8, 1923.

operation with some business organization that would establish an operation that should continue after the fund had been expended. The object of the fund, therefore, was to help in assuring a continuing business. It appeared as though there were numerous opportunities for such a constructive program. Two years' experience in trying to realize such an ideal failed to develop a satisfactory business connection. Subsequently, efforts to reach the same objective were begun in Canada through the appropriation of $650,000, by the provinces of Manitoba, Saskatchewan and the Dominion government. It seemed wise to await the outcome of this venture, while the Bureau of Mines followed a modified program. This program has just been completed, and a report will be issued. The net result has been that a report is now ready and about one-half of the original fund remains. The Secretary of the Interior has directed that a peat investigation shall be taken up. It has been erroneously reported that this would be an investigation of the peat resources of the country. Investigation of peat as it lies in the ground is a subject for study by the Geological Survey, and its uses in agriculture fall under that department. The object of this bill is to determine the present "commercial practicability" of the utilization of peat for fuel and certain by-products. Considerable work has been done of late along these lines by our Canadian neighbors, and by the Fuel Research Board of England. While the lignite investigation started with a rather well defined program of procedure, the program for a peat investigation along the lines of the bill is still a matter for determination. If peat is to be considered as a fuel the main problem is believed to be an engineering and business one of reducing the peat to possession at a charge which its value will bear. With practically no cheap labor in America this must be done by machinery. It is evident that the peat fund is not sufficient to engage in developing such machinery. At the present moment it seems that the most useful service that can be performed with the limited fund will be an investigation of the actual condition of the several peat projects in the United States, insofar as they have to do with peat as a fuel.

CELERY AND OTHER CROPS ADAPTABLE TO MUCK SOILS FROM A PRACTICAL VIEWPOINT[1]

By J. N. Hoff

My statement that the humus soils of this country, which are adaptable for agriculture, are fertile and productive soils, will, I am sure, not be questioned by those who have tried them out.

What other soil will stand up under such intensive cultivation with a continuous one crop rotation? What other soil will produce from $2,000 to $3,000 worth of crops per acre annually, as our best muck soils with proper handling, are yielding and will continue to yield?

In my own experience a goodly acreage of humus has been growing celery almost continuously for the past thirty-five years. In 1923 we produced $3,000 worth per acre of saleable crops, and a catch crop thereafter, which paid expenses of fertilizer and crop production for the entire season. It sounds pretty good, does it not? A fact too, exceptional, yes. But where the right muck soil exists, with good cultural methods and markets available, it is possible and can be accomplished.

Good drainage is essential, temperature and moisture conditions are basic to success. Beyond these factors, supply your limiting factor to fertility, which is usually potash, together with a modicum amount of quick nitrogen to offset lack of nitrification of the soil nitrogen in the low temperature of the spring, and phosphoric acid as plant food and bacterial energizer, and your results with celery and other adaptable muck crops will be assured.

Now take celery as a representative crop. It will do well in a slightly acid muck. Give it good drainage, plenty of available plant food, say ½ to ¾ tons of 2-8-10 fertilizer, cultivation, and a spray of Bordeaux Mixture, or Bordeaux Dust, every 10 days to 2 weeks, to prevent early and late blight, and results are pretty sure to come.

Select a good variety of celery, adaptable to your market. Give

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[1] Delivered at the Seventeenth Annual Convention of the American Peat Society held in Washington, D. C., December 6-8, 1923.

your customer what he wants, packed as he wants it; but try to excel in quality, uniformity and pack.

Blanche, preferably with boards, rather than earth, to avoid rust, especially in the summer season.

If your muck is raw, apply at least 10 tons of manure to the acre to start bacterial decay action, and liberation of plant food. Depend thereafter more on chemical fertilizer for plant stimulation. As at least two crops can be raised annually if you do not follow early celery with late, big Boston or Cos lettuce may be grown.

Potatoes flourish on good, well drained muck, giving excellent yields. Carrots, turnips and rutabagas, spinach, in fact all leaf crops are indicated.

Onions and their relations romp in such soil, in fact, if you will supply the essential mineral needs of the crop to be grown, practically all useful vegetables, as well as corn and other grains, will give good yields, provided you will look well to the drainage.

We all know that frost forms readily in low places; therefore, on the muck, for this reason, select as far as possible those crops which are most resistant to frost; with this in mind, coupled with good husbandry, profits are reasonably certain on muck soil when in the right agricultural condition.

This year, in early July, I saw a large area of celery, lettuce and onions, cut down and riddled by a severe hail storm. The grower wished to plow under the whole area and replant. The advice given was not to plow under anything except the forward lettuce, and clean up and cultivate the onions, celery and other crops. The result was, to this grower, his most successful year.

I mention this to show the wonderful "come-back," or resiliency of crops grown in muck and its rapid action in restoring damage from the elements.

Why is good muck so valuable agriculturally? It contains usually 40 times more ammonia, 10 times more phosphoric acid, and 20 times as much humus material (the life of the soil and natural food and habitat of beneficial soil bacteria) as does upland or mineral soil.

It is easy to cultivate, aerate and oxidize, produces in its decay plenty of carbonic acid, the important mineral soil solvent, which gives plant food in abundance, together with the even more important

feature of holding and giving up volumes more of moisture, and absorbing the life-giving heat from air and sunshine. All to the end that abundant and luxurious crops result.

Professor Beattie has written several bulletins which set forth in detail the best methods of planting, growing, gathering and marketing, the most important of our muck land vegetables.

THE FINANCIAL SIDE OF MUCK LAND DEVELOPMENT[1]

By W. C. Steenburg

Not many years ago muck land, at least in the middle west, was considered nearly worthless. In Indiana investors from Illinois and other states were looked upon with mingled feelings of amusement and pity. The native of Indiana considered that his neighbor from Illinois was very appropriately called "the sucker." When the ditch assessments were levied, however, this feeling rapidly changed, often. indeed, to one of open hostility. There was good reason for this hostility, for the residents had regarded their land as worthless, or nearly so, and then to have their fishing and hunting spoiled by draining the land and to be assessed for the cost was, in their opinion, only adding insult to injury.

While the value of muck land, if properly developed and farmed, is now an undisputed fact, still I feel that the financial success of future development, at least on a large scale, is more or less questionable. Particularly is this true when the area to be developed is located at a considerable distance from a good market, when the land lacks a proper natural outlet or fall, and when the muck is of an inferior quality or supports a heavy growth of brush.

Drainage an Important Factor

To make muck land most valuable it should have the proper kind of drainage. The drainage system should be carefully outlined by an engineer. Open ditches are satisfactory for the outlets and even in the laterals, although tile is to be recommended for the lateral ditches. The use of small tile for too long a distance, without increasing the size, is to be avoided. Tiles six inches in diameter, laid about fifteen rods apart, will usually give satisfactory drainage. Shallow, open ditches are a good precautionary measure, particularly in the case of the more perishable intensive crops where horse power is largely used

[1] Delivered at the Seventeenth Annual Convention of the American Peat Society, held at Washington, D. C., December 6-8, 1923.

in the land preparation. Often ditches not only make farming more difficult, but also need much attention, as they are inclined to fill with weeds in a rainy season and, in a particularly dry one with muck, unless suitable wind breaks are provided. Drain tile, then, is generally more satisfactory, but tiles should never be placed close to the surface, as the settling of the land has a tendency to bring them closer to the surface, where heavy tractors or implements may throw them out of line.

Clearing and Plowing

Brush may be cleared at a comparatively low cost, if proper equipment is available. I find the most satisfactory tractor to be a slow speed kerosene type, weighing about ten tons, equipped with drive wheels four feet wide, or double the regular width. The excessive weight of this tractor was sufficient to crush the brush, so that the special, four bottom, breaking plow would turn it under. With this unit it is possible to plow under brush ten or twelve feet in height and of such density that the tractor is practically obscured from view, at even a short distance.

Lighter less expensive outfits are now available and are very satisfactory, but the beneficial effect of the great weight of the heavier unit is not to be overlooked, if finances are not too important a consideration. Not only in breaking, but in future seed bed preparation, is this weight beneficial. A roller weighing approximately four tons can be purchased or constructed, that will roll the ground between the rear driving wheels. The use of this roller in making the seed bed more compact is to be recommended.

Special implements are essential. This is particularly true of the plow, as the ordinary so-called high land plow is not a success. With other implements the worst difficulty is that sufficient wheel surface is not provided to carry the weight on soft ground. Axles long enough to carry double wheels, rather than extensions, are less liable to break, particularly on the heavier type of tractor.

Muck land changes in character as it is farmed. If the land is covered with brush it is best to seed first to blue grass. Even sod when first broken is very spongy and unsuited for small grains, as the straw makes unusual growth while the kernel will be small and shrunken. This tendency, as well as the frost hazard, can be somewhat overcome by proper preparation of seed bed, combined with in-

telligent fertilization. The danger of small grain falling down before maturity is much greater than that of corn.

With truck crops many of these same difficulties are encountered, as well as several others. A greater price fluctuation is always evident, weeds are hard to control, insect enemies and plant diseases are frequently evident, particularly in fields where a systematic crop rotation is not followed out. The preference of commission houses and buyers for "high land" potatoes, while in many cases unfair, is, nevertheless, usually apparent.

Economic Considerations

While the per acre value of truck farming is high, the labor involved is so very great that the actual return on labor invested is usually less than in the case of general farming. Occasionally a man will make a success of a special crop because he handles it in a peculiarly efficient way.

The danger of overproduction in truck crops is very great. It would be possible, for instance, to produce all of the celery, onions, mint, and cabbage needed in the entire United States on less than 5 per cent of the muck land in the North Central States. The gross returns on special crops are sometimes very high, but it is not fair to take into serious consideration the unusual price which brings the unusual return in judging the value of land.

In the case of intensive crops, sometimes the district will move because the land no longer produces. One prominent Michigan grower had 1,900 acres of mint four years ago, but today has only 400. Nevertheless, the total acreage of mint has increased from 16,000 to 24,000, owing to the fact that more growers have come into the field. It would seem that mint really should not die out, if we understood how to care for and fertilize it to advantage, but, unfortunately, we have no standard to go by. It is expensive to move mint equipment and there is loss involved. An up-to-date mint still of moderate capacity can not be constructed for less than $2,500.

There are also disadvantages in raising a crop of blue grass. While it is possible to secure an abundant growth, often without seeding, still cattle do not thrive on this grass, as they do not satisfactorily increase in weight. The low mineral content of the soil in all probability accounts for the lack of nutrition in the grass.

Fertilizers Required

Even though a tract of muck land might be cleared and drained it would surely be a sheer loss of time and money, eventually, to farm without the intelligent and generous use of commercial fertilizers. It has always been a fact, recognized by all familiar with muck land that, while the land is high in nitrogen, it is deficient in potash. In more recent years the addition of acid phosphate to potash has grown in favor and the success of the combination, by all who have tried it, is undisputed. Potash alone will give a satisfactory yield, but phosphates hasten maturity and under normal conditions insure the quality of the crop.

A definite plan to be used over a period of years should be worked out, if possible. A ten-ten combination, 10 per cent potash and 10 per cent phosphoric acid is an ideal mixture for most crops. For general farming an average application of 200 pounds per acre per year over a period of years is certainly not excessive. With corn, the most economical method is to drill the fertilizer in the row with the corn, as only 100 pounds to the acre is sufficient. The deficiency between the needs of the corn crop and other crops can be made up when the fertilizer is broadcasted for other crops.

The ratio between the cost of needed fertilizer and the labor cost per acre is usually about the same. A fertilizer investment of from 10 to 15 per cent of the total labor cost is money well spent.

The Kankakee Tract

The Indiana tract, which I own and operate, comprises 3,600 acres, most of which might really be considered a good quality of muck. This land cost $200,000.00 in 1912. In the following three years $100,000.00 additional was spent in drainage, clearing and general improvements. These improvements consist of all necessary drainage, fencing, ten complete units or sets of buildings, each unit composed of one to four houses, and all necessary barns and granaries. Three mint stills, two side tracks, a general warehouse, bunk house, or hotel, and shop are also included. Conditions are apparently favorable and some seasons over 100 cars of produce have been shipped, yet the farm has never been a financial success, if a suitable interest charge is made on the investment.

The sale of the muck as humus, on a tonnage or yardage basis, to greenhouse men and landscape architects, has developed into a highly profitable business, but it can hardly be considered in the same light as the farming. I regard repeat orders from satisfied customers as proof of the merit of muck in this work.

While I have made actual sales of this land at $400 per acre to Hollanders for intensive farming close to the city of South Bend, yet if the entire farm were placed on the market at the present time, I question whether it could be sold for more than $125 per acre. This figure would just about cover the cost of the land plus the interest charge.

The government station, under the direction of James H. Beattie, which is located on this farm, is planned on a five year basis, and while no definite conclusion can be drawn until the completion of that period, many interesting and worth while points have already been brought out.

The activities here are divided into two distinct parts, first a study of the different varieties and kinds of vegetable crops to determine their adaptability to growth on muck soils, and second, a combination, rotation fertilizer study with four truck crops, i. e., celery, onions, cabbage, lettuce, and sod are so rotated that each set of plots or areas will be devoted to each crop included in the experiment once in five years. Each area is divided into forty-four plots, each receiving a different fertilizer treatment.

Excellent crops of high-grade vegetables have been produced, where the proper fertilizer and farming methods were used. No acidity and a deficiency of potash are the outstanding features of the fertilizer test. The need of planting the proper variety of lettuce, celery, sweet corn, cauliflower and cabbage, is very apparent, as the lack of uniformity of results obtained with different varieties is striking.

Sweet corn is particularly adapted to conditions found on these soils, but in order profitably to produce a large acreage, a canning industry should be established.

While I have yet to find any operator of a muck farm, either large or small, who will admit that he is really making money, over a period of years, after charging off a suitable interest rate on his investment and a labor charge for his time, still this condition is not confined entirely to the muck farmer. An eastern financial house care-

fully compiled figures on farming conditions for the last year, and they inform us that an average return upon the investment throughout the United States was slightly less than 2-3 of 1 per cent.

The profitable employment of muck land will probably come about through its utilization for all crops to which it is adapted, combined with proper fertilization, and farming methods.

NEWS OF THE INDUSTRY [1]

Peat Developments in Minnesota in 1923

By F. A. Wildes

During the past year considerable interest has been taken in peat as a possible source of fuel. However, no marked progress has been made in placing it on the market. Inasmuch as the interest taken has been so general, the outlook is much more encouraging than a casual survey would indicate.

Many farmers have made half-hearted attempts to use it and all who have reported indicate that so far as the peat itself is concerned, the results have been satisfactory. The chief cause of the slow progress is the lack of definite information on methods of harvesting. To overcome this the State Auditor, Ray P. Chase, has conducted some experiments at the mining office in Hibbing, has made demonstrations of its use at the state fair, and has distributed so far as the limited funds permitted, literature bearing on the subject.

A number of business enterprises have undertaken to use peat for heating and power. The Itasca Paper Company of Grand Rapids started late in the season of 1922 to install a plant on Corona Bog near Carlton, Minnesota. After harvesting and drying a quantity, fire destroyed the plant and finished product. As the season was then about closed, the project was abandoned. Nothing appears to have been done by the company since.

A theater owner at Princeton, Minnesota, has used peat successfully at his plant by simply shoveling the loose peat into the furnace as it comes partially dried from the surface of the bog.

The Mines Experiment Station at the University of Minnesota has been making tests of its use by small power stations and in destructive distillation in making producer gas. Some work has also been done in the use of peat fuel in the manufacture of pig iron. It is confidently believed that the station, if sufficient funds are available, will be able to announce something of much interest to the friends of peat utilization.

A firm under management of Mr. Van Clark has a plant located on Superior Boulevard, Minneapolis, by which the peat is to be

[1] Read at the Seventeenth Annual Convention of the American Peat Society, Washington, D. C., December 6-8, 1923.

relieved of its water and prepared for fuel by a chemical process. To date the product has not been placed on the market.

The City of Bemidji is investigating the feasibility of utilizing the large peat deposits in the vicinity as fuel for the city power plant which it is soon to take over from a private concern. The mayor and city council are investigating the matter.

An individual of Minneapolis has erected a plant for drying peat at the Corona Bog near Carlton. His plan is to screen the roots from the peat, macerate the pulp, press out a quantity of water and put the finely divided material through the drier. The peat is blown into the top of a vertical drum about forty feet high and twenty feet in diameter. Hot air is also blown in at the top and in its descent with the peat absorbs the moisture. The peat reaches the bottom of the drier with about twenty per cent moisture and heated to 200 degrees F. By decreasing the amount of peat fed in, a lower moisture content is obtained and vice versa. The pulverized peat may then be briquetted without binder. The product from the experimental plant has all the earmarks of a fine fuel. The inventor believes he has solved the problem of turning worthless peat bogs into sources of fuel.

The School of Agriculture at the University is doing a splendid work on peat lands at Fens, Kelsey, Meadowlands and other places. Dean W. C. Coffey and Dr. F. J. Alway deserve great credit for the work they are doing. No attempt will be made here to give in detail the results accomplished for they are fully set out in the bulletins.

Discussion Of Fuel Developments In 1923

Messrs. B. F. Haanel and C. C. Osborn both discussed attempted fuel developments in the United States in 1923. Both agree that some of the processes were too expensive and that if peat fuel were prepared by them it would cost far more than its fuel value. The statement was made that it was impossible to press a material quantity of water from peat because of the fact that it was held both

chemically and physically by the peat. It was believed that artificial drying is uneconomic and that it would take more heat to dry the moisture from the peat than could be obtained from the finished fuel. Those who entered into the discussion took the position that a very attractive fuel can be made from peat by elaborate processes, but that in every such instance the cost of production is excessive, and that peat, being a low-grade fuel, must be prepared in a simple manner at a low cost of production in order to compete with other fuels. The statement was made that there is no known chemical process for extracting moisture from peat at a price that is economic. Most of the so-called discoverers of the magic chemical processes for extracting water from peat have refused to state what the chemical is. The greatest handicap suffered by those who would attempt legitimately to produce peat fuel in the United States has been the lack of intelligent engineering advice and the extravagant claims of promoters who would take a low-grade material with a high water content and attempt to produce a fuel from it equal to coal at a cost lower than the expense of mining the superior fuels. The sooner these facts are recognized and it is generally appreciated that peat is a low-grade fuel and must be produced and sold at a low cost, the sooner its commercial production will begin in the United States. The air-drying machine process is the only known one that offers promise in North America for economic production at low cost in commercial quantities.

Canada

Experiments in the production of peat fuel by the simple air-drying process have been completed by the Government of Canada, and a private company, called the "Peat Fuels Limiteds," of Montreal, has taken over the project at Alfred, Ontario. It is stated that the company will immediately begin the operation of the plant, and that it is expected to produce a considerable quantity of the fuel for next winter's consumption.

Operating on a small scale last year, 3,000 tons of the fuel were

marketed by the Government and burned in kitchen stoves and grates, and it is said to have been a satisfactory fuel. The selling price was reported at $5.00 a ton. According to a preliminary report of the Government Peat Committee, the cost of producing varies from $3.50 to $4.48 per ton, depending on whether the plant is operated on a basis of 20 or 10 hours a day. The president of the new company is Kennedy Stinson, president of the Stinson-Reeb Builders Supply Co., Limited, of Montreal. Mr. Ernest V. Moore, Consulting Engineer, of Montreal, is a director of the company. Mr. Moore was supervising engineer of the Government experiment.

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Thos. F. Manns, Plant Pathologist and Soil Bacteriologist, University of Delaware, Newark, Delaware.

Address communications for committee to J. H. Beattie, McLean, Virginia.

SCOPE AND PURPOSE OF SOCIETY

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. It is an organization devoted to research and to the dissemination of information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat and muck.

Through its Advisory and Research Committee, consisting of botanists, geologists, chemists, bacteriologists, and engineers of recognized standing, the society will answer inquiries from members relating to the use of their deposits. There is no charge for general service.

NATURE AND USES OF PEAT AND MUCK

Peat and muck are residues resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas covered or saturated with water. They may be identified as the dark-colored soils found in bogs and swamps and in other low places. The commercial uses of peat and muck are varied. In the United States they are utilized chiefly as crop soils, as soil conditioners, and as ingredients of fertilizers. In some of the countries of Europe peat is used for fuel and is the basis for small manufacturing industries. Gas, charcoal, coke, and some by-products are produced in small quantities. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of litter, packing material and rugs, and selected varieties of peat moss have been used to make surgical dressings.

ECONOMIC ASPECTS OF PEAT

The United States contains over 12,000 square miles of undrained peat and muck land. The average deposit, if used for industrial purposes, will yield 200 tons per acre-foot. It is estimated that the deposits would be capable of yielding about 14 billion short tons of air-dried peat. Peat and muck areas are distributed throughout the Great Lake, Pacific Coast, and Atlantic Coast States. Peat and muck in Canada cover 37,000 square miles. According to published statistics, European countries annually consume about 50 million tons of peat fuel

MEMBERSHIP

Present membership of the American Peat Society consists largely of agriculturists, engineers, and peat and muck land owners and producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetable matter, and in the production of fuel or generation of power, may join. Applications should be addressed to the secretary. Membership and subscription to the Journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS

Meetings of the Society are held annually in important cities throughout the peat regions. Papers are presented relating to the subjects enumerated. A quarterly journal, containing the proceedings of the Society, papers concerning all phases of peat, muck, and allied subjects and news of the industry, is published and sent to members. The scope of the papers is very broad, including the location of deposits, drainage and reclamation problems, methods of cultivation, fertilizer requirements, crop adaptation, cultural practice, physical and chemical characteristics, engineering practice, and production methods. One of the principal objects of the Society is the exposition of extravagant claims made by promoters.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society.

(Date)

Mr. Charles Knap, *Secretary-Treasurer,*
American Peat Society,
2 Rector St.,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This action is prompted by my interest in the science and utilization of peat and muck and the welfare of the society.

Yours very truly,

(Signature)

(Address)

CONTENTS

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Chapel Hill, N. C.

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NEW COMMITTEES FORMED

THE BOARD OF COUNCILLORS

In accordance with a motion passed by the Executive Committee at the Seventeenth Annual Convention and with the annoucement made in the January Journal, the Committee appointed to form a Board of Councillors to lend advice and support to the Society has made progress. Up to the present time the following persons have been appointed. Each of these persons has contributed $200 or its equivalent to the welfare of the Society and of the science.

Chairman—Charles Camsell, Deputy Minister of Mines, Ottawa, Ontario, Canada.
James H. Baldwin, 295 Fifth Avenue, New York, N. Y.
John N. Hoff, 2 Rector Street, New York, N. Y.
W. C. Steenburg, 228 South Main Street, South Bend, Indiana.
C. Campbell Osborn, Ponca City, Oklahoma.

THE ADVISORY AND RESEARCH COMMITTEE

The Advisory and Research Committee has also been formed and is now prepared to serve the members. As organized at present, this committee consists of the following persons:

Chairman—Frederick V. Coville, Botanist, U. S. Department of Agriculture, Washington, D. C.
Acting Chairman—J. H. Beattie, Horticulturist, U. S. Department of Agriculture, Washington, D. C.
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Thos. F. Manns, Plant Pathologist and Soil Bacteriologist, University of Delaware, Newark, Delaware.

Communications should be addressed to Mr. James H. Beattie, Acting Chairman, McLean, Virginia. The committee will render advice without charge to the owners of peat and muck land, and will pursue research work. Meetings will be held in Washington at regular intervals, probably monthly, at which problems will be discussed and new developments brought to light. The committee has been established for the purpose of supplying members of the Society information on peat and muck in North America, and as far as possible in other parts of the world; of outlining and assisting in the carrying on and summarizing of experimental work on mucks and peats; and of bringing about a better understanding of the uses of these materials as crop soils, as sources of organic matter and plant food for greenhouse use, as mulches and dressings for flowers, shrubs, vegetables, fruits, and other plants; as fertilizers or fertilizer ingredients, as a source of nitrogen; as fuel, as packing material, as antiseptic dressings, and for other purposes.

The committee includes botanists, horticulturists, bacteriologists, geologists, engineers, and chemists, all of whom are giving their time free of charge. The members of this body will endeavor to give as complete and definite information as is possible in reply to every inquiry coming from members of the Society. Specific requests will be handled by the members of the committee within whose field the inquiry naturally falls. In making use of this service it is distinctly understood and agreed by persons receiving information from the committee that the name and advice of the committee or its members are not to be used or quoted for advertising or promotion purposes.

SOME NEEDED PEAT INVESTIGATIONS [1]

By David White [2]

The history of discovery in every branch of the earth sciences shows the inseparable relationship between the results of inquiries prosecuted in the search for pure scientific fact and principle, on the one hand, and, on the other, for useful products and new applications of commodities or principles already discovered. The discoveries in pure sciences may in a moment be transformed into economic necessities. Today's curiosity may be tomorrow's triumph. Accordingly, I venture to hope that the lines of inquiry which I shall discuss may prove of interest, or in some way helpful, although they reflect a narrow point of view that, further, is circumscribed by ignorance of progress in peat usage and peat literature, since they originate in, and for the most part relate to studies which I am pursuing of fossil peats. That coals of different ranks and of different geologic epochs are nothing else than peats carried forward under dynamic influences to varying stages in an evolutionary process, ending in anthracite, and finally in graphite, is presumably well known to peat students, though it would appear that there are many Old World geologists who do not yet fully recognize this truth.

The questions which I present relate mainly to the deposition or formation of peats of different kinds, the changes undergone by the ingredient plant commodities in the process of peat formation, and the special chemical characteristics imparted to any given peat by the amount and the chemical composition of the dominant type or kind of ingredient matter. All these inquiries are based upon the well established conclusion that the chemical characteristics and the structure, including all the physical features of a peat, are determined and controlled by the kinds of plants and animal debris contributed to the peat growth and by the factors of the environment conditioning the deposition, chief of which are the water and the temperature. The important part played by the water level, by stagnation, by flushing, evaporation or drainage of water from the peat forming area, or even by rainfall, in regulating the growth and the kind of peat, is more or

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[1] Published by permission of the Director of the U. S. Geological Survey.

[2] The author of this paper would much appreciate the favor if members familiar with the questions raised would furnish him the answers or refer him to pertinent printed data.

less familiar to peat men and probably needs no further consideration in this connection. Also the effects of heat or cold, dry seasons or aridity are elementary to the peat student.

Effect of Resin And Wax Concentration

(1) The greater part of the vegetable matter growing or falling on the surface of the peat bog or swamp is more or less woody—so-called vascular plant growth—and much of it contains resinous or waxy material. Everyone is familiar with the wound resins and waxes which exude from the bark of trees, branches, fruits, etc. Many kinds of trees contain great amounts of resins or gums as microscopical lumps in the wood cells and vessels, and the aggregate of these is enormously greater than of the resins visible to the naked eye. Resin-bearing trees, including coniferous evergreens, are found in most swamps and bogs. When the rate of contribution of the vegetable debris, which practically always contains more or less resin material, is slow, and especially when the surface of the peat is not sufficiently wet to check decay; or when the latter is flushed so as to bring oxygenated water into contact with the decaying vegetation, the woody material very largely decomposes and is carried off in solution, leaving, however, the decay-resistant resinous and waxy contents of the cells, wound resins, etc., behind, with the result that the latter are actually concentrated as the result of the removal of the accompanying and surrounding plant matter. Such concentration occurs at different levels in many peats according to the conditions that have prevailed on the bogs, and are seen to have similarly occurred in the formation of coals of all ages. Deposits in which the woody material has decayed leaving the resins, etc., in such increased proportions, present distinctive chemical characteristics as well as special physical features. Chemically these peats present larger proportions of volatile matter. Their B. t. u. values are high, due to the large amount of hydrogen and usually lower oxygen content, though they may be rather high in ash. Structurally they are generally very-fine-grained, and in some cases are included in the so-called "amorphous" peats. No doubt deposits or layers of this type are familiar to peat producers. How often is such peat found to be brown or reddish brown? How does its highly resinous composition affect the use of such peat (a) as raw fertilizer on some soils, (b) as filler in commercial mineral fertilizers, (c) as preservative or antiseptic, (d) as fuel to be cut, dried, and marketed in the ordinary way, and (e) as raw material, or perhaps better, as binder to be used in briquetting other

peat or other coaly material. Non-fibrous resinous or resin-waxy peat might dry more easily, and in the right retort should give gas larger in volume and more effecient. Peat men probably know whether peat high in resin concentrates is unusually acid, or less acid than normal; also how the resin affects soils of different types, and the application of the peat to different uses.

The Open-Water Peats

(2) Somewhat related in genesis to the layers or deposits rich in resin concentrates are the peaty deposits laid in open water, such as ponds or bayous, in which the accumulations have the aspect of coze, probably black. They are "amorphous;" and if the water body is not too large and it occurs in the midst of a bog or swamp, this ooze will contain considerable amounts or resin derived from the decomposition of indrifted and infallen woods, besides which it will contain much resinous or resin-wax material resulting from the survival of the horny exines of spores and pollen grains and from the special protective coverings of seeds and scales which are designed by nature to resist decay, and which, accordingly, are left behind when the ordinary woody matter and the soft parts of plant and animal structures have disappeared as the result of biochemical—essentially bacterial—decomposition. When the water is laregly or practically stagnant and inward drainage does not bring in too much silt, mud, etc., of inorganic mineral composition from the outer land, these pond deposits which represent most nearly a typical "amorphous" peat, correspond exactly to what in fossil peats are known as cannel coals and cannelloid shales. These open-water deposits, which are, I believe, generally classed as "mature" peats, and which, if the ash is low, are, like the resinoid peat layers of the swamp, moderately high in calorific value, should have special applications. I presume they may not be so acid as the woody or fibrous peats. Presumably they would have little value as litter, though unless the resin and resin-waxy or higher fatty elements derived from spore and pollen envelops, fragments of horny skin, etc., give chemical characteristics deleterious in fertilizer, they should be well adapted for use as fillers, besides which they are liable to contain rather larger proportions of nitrogen than other peats. How do they compare with resinous and fibrous peats when mixed with feed? Probably they have little value as fuels on account of their structure, though they should yield very much gas. What is their value as binder or for special purposes? Have they been used in gas generation? Are they harder to dry than fibrous peats?

These deposits, which are, I believe, little used by the peat producer, have special qualities and may some day enjoy more widespread use for special purposes. Probably deposits of this type are found beneath portions of some bogs or swamps. In other cases such matter is very likely intercalated between other beds of more or less distinctly fibrous or normal peat. The physical characteristics of these open-water "amorphous" peats are readily observed under the low power microscope when the material is washed out on a glass slide. Mechanical separation will permit the segregation of concentrates from these as well as from the resin types mentioned above.

The open-water "amorphous" peat is richer in hydrogen, and, through the cannel coal group, approaches nearer to the richly bituminous shales or oil shale group of organic deposits from which artificial petroleums or distillates closely approaching natural petroleum may be obtained by destructive distillation, and which are believed by many geologists to constitute the ideal mother substance from which, in the outer crust of the earth, petroleum has been produced by geological processes, constituting what is in effect natural distillation. There are, on the other hand a few geologists who believe that petroleum is generated in the biochemical decomposition procss taking place at the surface and in the upper part of the peat deposit at time of formation, and that oil's thus generated are buried as disseminated minute globules to be gathered by coalescence in the course of migration, when, in a later geologic period, under stresses compressing and folding the strata, the water, marsh gas, oil globules and other gases are squeezed out of the organic debris and driven along in directions of least resistance to ultimately find storage and gravitational differentiation in an open-pored sand or other rock favorably bent in anticlinal or arch structure. It would be interesting to know how commonly peat operators find globules of oil buried in the midst of the peat. It would be helpful to the geologist if close observations were made, care being necessary, however, to distinguish between oils and irridescent iron-bearing water. The tests to distinguish the iron oxides from oil are very simple and are probably known to peat specialists.

In this connection it may be well to add that there are many plants which, like some of the mints, contain oils in large amounts and which may be contributed under certain conditions to the peat forming ingredient batch, though the mints, which do well on muck, are not, I believe, so frequent habitants of the peat bog. My own impression is that oils such, for example, as peppermint oil, are de-

composed at the time of the decay of the plants in the peat-forming process, and that these oils, in their original composition, take little or no part in the formation of the peat or in determining its chemical character; and that the vegetable oil of the growing plant, whether herb, shrub, or diatom, disappears as the result of the putrifaction processes of bio-chemical decomposition as the organic debris is converted into peat. Some empirical and practical field observations bearing on this question would be most welcome, I am sure, to many of the petroleum geologists, numbering over 1,000 in the United States.

Nitrogen Content

(3) What is the present status of observation as to the relations between the general type and composition of the peat and its nitrogen content; between the types of ingredient plant or animal debris which compose the batch from which peat eventually emerges after cessation of bio-chemical decomposition; and what influence is exerted by water level or change of water on the amount of nitrogen in the peat? Is nitrogen carried off by flushing or drainage of the bog and is it conseved where the water cover is ample, stationary as to level and stagnant? The writer is not sufficiently familiar with the literature on peat to know how much has already been learned or may even be common knowledge on this subject which, nevertheless, is an important one, since it holds the key to the explanation of the presence or absence of unusual amounts of nitrogen in coals of different types, in oil shales, and in the distillates from coals and oil shales, the latter being a matter of great importance. Is there any observation showing that in bogs in which a permanent water cover is maintained throughout the year, as is the case in many of the southern peat swamps, the amount of nitrogen is unusually large or that possibly animals of different types living in the water, and in general more richly nitrogenous than plants, may have contributed extra nitrogen to the peat deposit? The question as to the part played by animals as possible contributers of nitrogen to the organic sediments, peats, peaty muds, organic oozes, etc., is still an open one. It is, however, rather remarkable that further progress has not been made in its solution. The peat operator and the peat student hold the answer in their hands. Is nitrogen more abundant in peats intercalated with salt marsh deposits or in beds laid down in the slightly saline zones than in peat formed in the strictly fresh water?

Since the selective biochemical decomposition of the vegetable

and animal material entering into peat formation is essentially microbian—i. e., the work of bacteria of different types—it would seem reasonable to hold as a working hypothesis, at least, that on the kinds of bacteria performing this work may depend largely the amount of nitrogen locked up in the peat and its combination, which means its degree of "availability." Naturally, bacterial operations and the kinds of bacteria participating therein must be controlled to a large extent by the environmental conditions, character, composition, depth stability and temperature of the water, as well as by the nature and composition of the organic debris. The question attaches itself to the experiments and results of artificial enrichment of nitrogen in peats and the processes which take place during such enrichment. It also concerns the adaptability of different types of peat to bacterial increase of nitrogen under artificial conditions of production and manufacture It may well be asked, whether the limit of induced nitrogen enrichment, especially to the increase of available nitrogen, has yet been reached. A question so important and far-reaching from the economic standpoint may be presumed to have had widespread consideration and extensive experimental research with reference to every type of peat as well as to variation in the natural as well as the artificial factors of environment.

Salt Marsh Peats

(4) What is the importance, what the ordinary or special values, and what the distinctive features of salt marsh peat? The question is a drag net set mainly for my own information. My own idea is that very little peat of value is or ever has been laid down in salt water, like the sea or even moderately brackish water, and that all our Atlantic Coast peats that are thick enough or pure enough to be of value, are fresh water deposits. What merit, if any, has a salt water peat? What is the greatest observed thickness of strictly brackish or salt water peat of continuous deposition, and what are its physical conditions and characters and how high is the ash? In the coal measures of different epochs we find coal beds laid down so near tide level that they were eventually overswept by the sea as the result of coastal subsidence, similar to that now in progress along the south Atlantic coast; but the coals are fresh water deposits.

Rate of Peat Formation

(5) Another question of much scientific interest and some curi-

osity, is that of the rate of growth of peat, and so of coals of different ranks. The data relating to the rate of peat deposition are on the whole very unsatisfactory; statements conflict, and criteria of doubtful value are in many cases employed. Most of the observations and evidence, good, bad, and indifferent, relating to the rate of growth of peat in the bog come from northern regions, mainly in northwestern Europe, where the peat deposits were mostly formed since the retreat of the last great ice sheet. Are there not facts that have been observed or are observable indicating roughly, at last, the rate of growth of peat per year or per century in peat swamps, possibly like those of the middle or south Atlantic States, in regions outside of the glaciated parts of the continent? Data from areas of deposition of fresh water peat in the non-glaciated regions are, from the geological standpoint, far more valuable than those gathered from post-glacial bogs in the northern regions, for several reasons. Principal of these is the abnormally cold climate, with its accelerative influence on peat formation in these regions; another is the abnormal physiographic environment, and still another, which may be far more important, is the generally longer period of peat growth under conditions of submergence or intermittent submergence in prevailingly wooded swamps in the warmer regions of peat formation. The rate of peat accumulation necessarily varies with the climate and the composition and state of the water. Any reliable data bearing upon the rate of peat growth in any part of the world are of interest. I may add that criteria relating to the rapidity of normal surface growth are of greater interest than the rate of growth of replacement peat.

Degree of Acidity

(6) To what extent does the acidity vary at different levels of a peat deposit, the deposition of which has been continuous? What if the deposition has been interrupted (discontinous)? What is the case in replacement peat—that is, second growth taking the place of peat cut from the bog? Doubtless there are records and observations relating to Old World peat bogs that bear on this question. Have we such records in America? The inquiry concerns not merely the varying acidity, which is really varying chemical composition, of peat at different levels in the bog or swamp; it affects the question as to the continuation of bacterial activity at considerable depth in the bog. It is claimed, for example, that bacteria possibly dormant but presumably capable of functioning, have been found as low as

20 feet or even deeper in the bog. Data as to the depth at which microbian activity (biochemical decomposition) may continue before final suspension in some peat deposits are, so far as I am aware, extremely vague and lacking in conclusiveness. It is evident that if the decomposition through bacterial agency continues to considerable depth the products of the vital activities of the bacteria, which are acid, should gradually increase in amount and the acidity of the deposit should increase downward, the conservation of the ulmo-humic toxic products of the bacterial activity being assumed to continue. Have we good data as to the maximum acidity to be observed in peat? In other words, what is there maximum acidity and what is the type including the structure of the peat which contains it, and what are the conditions of its occurence?

The occurance of neutral or alkaline peat at some level down in the peat deposit would appear to call for an explanation as to the history of the deposition of the peat. First, however, it remains to be shown that alkaline beds actually are present in the midst of normal peat, apart from salt marsh invasions.

Humic Acid Precipitation

(7) Since the so-called humic acid, ulmo-humic acid, or ulmo-humin—whatever name is employed—may be specially concentrated (a condition aimed at it in the previous inquiry) at certain stages in the deposition of the peat, it would appear probable that the irregularly shaped aggregates, sometimes pebble-like, of the so-called "dopplerite," which is composed of humic acid, marked such stages or zones. Is dopplerite noticed frequently in our American peat bogs? What shape does this supposed concentration of humic or ulmo-humic acid take when it is precipitated? Very likely dopplerite may be present in some area but it may have escaped attention. It would seem reasonable to expect it in zones of greatest acidity, though if the ulmo-humic mass in solution in the peat bog waters and imparting the tea color to the run off, or the brownish inky color to the deeper water within the peat, is precipitated by the invasion of alkaline waters into the bog, it is conceivable that an acid precipitate might be overlain by peat subnormally acid. The latter probably differs somewhat in structure and type.

(8) The last question develops another: that is, to what extent does diffusion between the aqueous solutions, supposedly acid

and certainly collodial, in the different layers or strata of the bog take place, and does this diffusion obliterate to some extent, at least, the acidity variations and other peculiarities of the humic solutions at different levels in the deposits? Is there any evidence of upward circulation, practically vertical in direction, causing transfusion of the concentrated waters from lower to higher levels in the bog? There should be—there must be—if only by reason of the greater compression and consequent shrinkage of the peat toward the bottom of the bog. The question of conservation of the biochemical products, including of course the toxic or so called humic elements, depends largely on the degree of stagnation of the water at or covering the surface of the growing peat, though it must be notably affected by the extent and depth to which the biochemical decomposition (bacterial action) continues down in the peat. Evidence of downward diffusion would, of course, be conclusive.

A correlative question is, how far does the effect of flushing or slow replacement of the acid water covering, or at the surface of the peat, extend downward into the peat? It would be interesting to know how close acidity may prevail and remain beneath the surface of the peat when non-acid and even oxygenated waters spread over the peat forming surface. Such waters, of course, arrest peat formation temporarily, or at least retard it. If continued they promote the decomposition of the top of the peat into carbonaceous mud or amphorus peat, much as the far greater oxidation resulting from the exposure of the surface to air leads the deterioration of the peat and its degradation to muck. I am assuming that where peat forms with great rapidity by reason of voluminous contribution of plant matter, the proportionate losses of the vegetable debris by decay are brought to a minimum: twigs, branches, seeds, logs, leaves, etc., may be in maximum evidence, and the ulmo-humic collodial waters within the peat itself will be notably acid. Such rapid deposition is, of course, greatly favored by stagnation of the water cover and consequent acidity at the very surface of the peat. Cool climate cooperates with luxuriance of plant growth in the latter's tendency to smother decay and raise the zone of acidity.

(9) The writer would welcome information from peat bog students as to either chemical or microscopical studies, or as to experiments in the precipitation of the ulmo-humic brown matter in the peat bog water, as the latter may be squeezed out of the peat or as it escapes in the brownish drainage from the bog. Perhaps some member

of the Society has carried on these experiments or will kindly refer the writer to publications in which the results of such studies have been recorded.

The Sulphur Content

(10) It is assumed that investigations relating to the presence, activities and products of sulphur bacteria in peat bogs have been carried out by many who are engaged in peat researches. All peats, all coals, contain sulphur, generally diffused in microscopical or very small spherules or flakes. Bacteria may be presumed to have taken part in this sulphur deposition, in some cases working independently or perhaps accessorily to the normal chemical reaction in the formation of marcasite (iron sulphide). I may add that my observations of coals and coal fields appear to show that sulphur in the form of iron sulphide is far more abundant in coals receiving drainage from limestone country contributing sulphates to the waters, or in regions receiving run-off from gypsum-bearing formations, or regions where semi-aridity favors the contribution of sulphates to the run-off into the bog or swamp.

(11) Are nitrogen-fixing bacteria efficiently functional at any considerable depth below the surface of undisturbed acid peat?

Geologic Age of the Peat and Associated Deposits

(11) Are nitrogen-fixing bacteria efficiently functional at any tion of drainage ditches and canals offer unrivaled opportunities for the discovery and collection of fossils, both animal and plant, that lived while the peat or underlying and associated sediments were being deposited. The preservative effects of the humic acid matters in the peat have resulted in the survival of remains of most interesting animals and plants in some of the bogs of northern Europe. These discoveries are simply invaluable for the light they throw on former continental outlines and relations and on the climates, which, as shown by the preserved remains of animals and plants, in many cases were quite different from those of the same regions at the present day, Large bones of elephants or mastodons have been found. These are readily noticed because they are very large and they of course attract special attention, since they show a distribution of animal life that is strikingly different from that now obtaining. There are chances of discovering skeletons of the Musk-ox and many other interesting types. All kinds of fossils should be watched for and very carefully saved,

for it is important to bear in mind that the bones of small animals, well preserved leaves and leaf impressions, and in many cases even fossil shells, may be as valuable and interesting as scientific discoveries as are extinct elephants or bears. It is greatly to be hoped, therefore, that the interest of workmen and foremen may be enlisted in the watchful observance of any occurrence of such fossils. The stories that they have to tell are really exciting. Finds should, therefore, be reported to the Geological Survey, the National Museum, or some other museum. If given the opportunity such survey or Museum will, if possible, send a specialist to view the occurence and take care of the uncovering, preservation (which sometimes require skill and training) and packing of the fossils. In most cases the fossils will have no appreciable commercial value, but their scientific value is of the highest order.

If workmen and producers are watchful it really is not unlikely that bones of man will be brought to light as well as other bones. It is not impossible that they will be associated with the bones of elephant or mammoth. They ought to have lived together in America, as they are known to have lived in Europe.

The discussion of the occurrence of fossil remains of the most important scientific and historical value in the peats and peaty deposits of America reminds me to remark that the old idea that these animals had sunk from the surface deep down in the bog is now known to be impossible. Animals are, of course, heavier than water and will sink to the bottom of water, but peat is heavier than water, and while animals will sink down into peat and peaty water until they are nearly covered or possibly covered—lost in any event—they will not subside below the surface of the peat and will not sink appreciably into the ooze and mud below the water provided they are already fully submerged in the water. The relative density or gravity of the animal mass does not permit it. Further, even if the gravity (density) of the animal were greater than the peat, the structure of the peat would be resistant to any sinking of any animal completely below the top of the bog, that is, the peat itself. In short animals do not sink entirely below the surface of the peat; they do not settle down deep into the mud of water-covered peat after they are fully submerged. In follows, therefore, that when animal remains are found distinctly below—say a foot or more—the surface of the peat those animals were mired before that foot or more of peat had been deposited. The deeper the burial of the animals the more remote is the day in which the animal lived. It is readily seen then, that if, as

appears to be the case, peat formation began in many of our northern bogs immediately on the retreat of the Wisconsin ice sheet—i. e. not less than 12,000 years ago—animal remains found deeply buried in the peat or near its bottom may be five, eight, or ten thousand or more years old. Certainly the discovery of human remains with animal skeletons at such depth would be more than interesting. It goes without saying that many animals other than elephants that will have been found fossil in our peat deposits are now extinct or no longer live in North America.

Other questions in the writer's mind do not require answer, though some may deserve reflection. Among them are those as to whether the study of the physiological action of peats of varying composition, especially of varying acidity, on different types of plants, is going forward in all the volume and diversity that the subject appears to merit. Another relates to the sufficiency of studies as to the therapeutic values of peats—especially of the various known and possible peat products, and the desirability of promoting researches in this field of peat utilization; also more extended utilization of peat for sanitary and surgical purposes.

It may be taken for granted that peat producers and economists are giving consideration to the possible practicability of utilizing peat on a small scale for fuel in certain regions like northern New England and upper Michigan and Minnesota, remote from the coalfields and subject to very high freight rates.

Presumably, high cost of labor is a serious obstacle, besides which, nature has blest most of these regions with abundance of wood as well as plentitude of peat.

Some of the questions propounded in the foregoing parapraphs are probably superfluous, relating to well known and well recognized facts, and may serve no other useful purpose than to reveal the writer's ignorance regarding peat, which he has in reality had little opportunity to study except under the disadvantages of attack on the fossil and generally more or less altered state. Charity, as well as tolerance, is, therefore, begged.

A ROLLER FOR USE ON PEAT LAND

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Drainage and Wet Land Development

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It was observed by White and Conzet while investigating the agricultural possibilities of peat lands under the drection of the writer in 1910 and 1913 that a marked improvement in the appearance of crops occurred wherever tractors or heavy machinery had passed over the surface. These observations suggested that compacting the surface of peat lands would increase the crop yields. In 1915 Dr. F. J. Alway, Chief of the Division of Soils of the University of Minnesota, invited the attention of the writer to references in foreign literature relative to the agricultural value of consolidating peat soils and suggested that he design a heavy roller for this purpose. Eugene C. Crane, an assisttant engineer then in the employ of the writer, was assigned the task of working out the details of a roller that would give the desired compression when passed over the surface of peat soils. A study of the data collected by the writer, and that supplied by Dr. Alway indicated that satisfactory results could be secured by a weight of 700 to 800 pounds on each lineal foot covered by the roller. This weight also appeared to be about as great as could be operated in the form of a roller on the average peat soil. After considering several methods of construction it was decided that the most satisfactory result would be obtained by using a metal shell filled with concrete and mounted in a suitable frame. Two rollers were built in the early spring of 1916 by Mr. Crane under supervision of the writer and placed in operation that season on experimental peat fields cultivated under the direction of Dr. Alway. These rollers have been used each season, as well as several others built along the same design and operated on peat land farmed under the general supervision of Dr. Alway.

As these rollers, so far as the writer is informed, are the first heavy rollers built in this country for the purpose of consolidating loose surface soils it is thought a description of the design and construction might be of general interest. A description of this type of roller is considered the more desirable since it is not carried in stock by dealers

in agricultural implements, and it has been necessary for users to have it built locally. The dimensions, weight and general design of the two rollers built in 1916 have been adhered to in those of later construction, but the styles of frame, shell and insertion of the shaft have been altered to meet the supply of material and qualifications of workmen available in local shops.

The following discussion covers the original design and construction with such modifications as appear practical and desirable after eight seasons of experience.

Diameter of Roll. A roller of small diameter offers an unnecessary amount of tractive resistance in loose ground while one of large diameter is easily turned on end unless the length is correspondingly increased. It therefore becomes necessary to select a filling material that will give the required weight per lineal foot of bearing length with a workable diameter. Concrete made with good aggregate and well tamped weighs approximately 150 pounds per cubic foot. A cylinder of a given diameter will hold the following cubic contents and weight per foot of length when filled with concrete.

A cylinder 28 inches in diameter contains 4.28 cubic feet and weighs 642 pounds.

A cylinder 30 inches in diameter contains 4.90 cubic feet and weighs 730 pounds.

A cylinder 32 inches in diameter contains 5.58 cubic feet and weighs 837 pounds. To the weight of the roll will be added the frame which will increase the total weight 20 to 40 pounds per lineal foot. From this computation it can be seen that a roll 30 inches in diameter filled with concrete and mounted in a frame will give a pressure of approximately 750 pounds per lineal foot of length. Such a roll has been found satisfactory on peat and is recommended for general use.

Where a lighter roll is desired the same diameter and construction can be used and the roll lightened by casting hollow cylinders throughout the roll length. Cylinders 6 inches, 8 inches and 10 inches in diameter will decrease the cubical contents and weight per lineal foot of the roll as follows:

A cylinder 6 inches in diameter contains 2.0 cubic feet and weighs 30 pounds.

A cylinder 8 inches in diameter contains 3.5 cubic feet and weighs 52 pounds.

A cylinder 10 inches in diameter contains 5.4 cubic feet and weighs 81 pounds.

Four 8 inch hollow cylinders cast in a 30 inch roll will decrease the weight 208 pounds per lineal foot. (Fig. 8).

Length of Roll. The length of the roll is determined by the:

(1) Ease of turning at end of field.
(2) Ease of transportation between distant farms.
(3) Motive power available.

(1) A long roll has a tendency to dig into and shove the earth ahead at the end towards the direction of turn, where continuous rolling from one side is practiced. The independent movement of two short rolls loose on the shaft renders it much easier to turn in any direction than a single roll of a length equal to two short rolls.

(2) To save time and prevent wear on the rolling surface in transporting the roller over roads it should be hauled in a wagon or truck. A long roll not only has double the weight of either one of two short ones, but its length may require that it be loaded endwise, a difficult task with such a weight. The shorter ones can be rolled on an inclined timber into the vehicle body.

(3) There is a limit to the weight of horse-drawn equipment which can be economically used on peat. Since a certain weight per lineal foot for a roller to accomplish its mission is necessary, the total weight of the implement must be controlled by length and not diameter. Practical experience in the cultivation of peat the past eight years would indicate that approximately a ton and a quarter in the form of a roller is sufficient load for the average farm team. This weight can be acquired in a total length of 42 inches of a concrete filled cylinder 30 inches in diameter.

Where large tractors supply the motive power the total length of roll can be greater than in horse drawn equipment. The weight of the tractor bearing down through the wheels may approximate that of the roller making it only necessary to cover by roller the land between the tractor treads which in the smaller farm tractors is 38 to 42 inches. The width of tractor tread is thus added to the width of land rolled at each passage of the equipment. Where the tractor tread is not sufficiently heavy to meet the packing requirements of the soil it is necessary to cover the entire field with the roller, in which case it will usually be found that a ton and a quarter is sufficient load for the tractor.

Fig. 1. The first roller, built in 1916, for compacting peat soil. Length of rolling surface 42 inches, weight 750 pounds per lineal foot. Two rolls each 21 inches long, 30 inches diameter, ¼ inch boiler plate welded seam shell and filled with concrete. Shaft loose in roll.

Fig. 2. Roller with wooden frame. Roll 42 inches long, 30 inches diameter, shell 22 gauge galvanized iron, shaft fixed in roll. For tails of frame see Fig. 3.

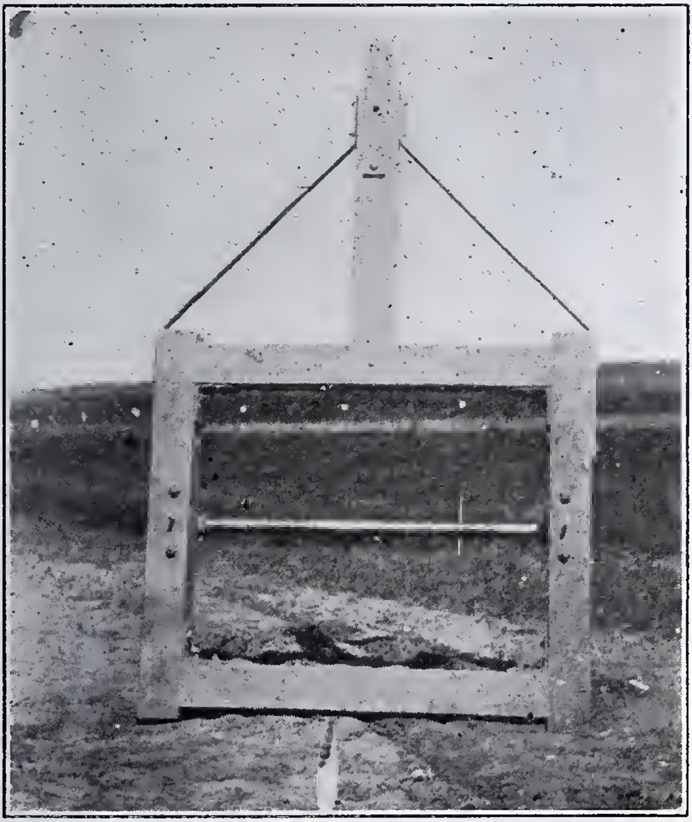

Fig. 3. Details of frame for roller shown in Fig. 2. Timber, pine 5¼″ x5¼″ held together on the inside corners by 5″ angle irons, each flange of the angle fastened to the timber by two bolts. Regular commercial shaft bearings attached to under side of each end frame by two bolts. Shaft 1⅞″x4′-6″ held in place on inside of each bearing by 1″ collar with set screw. Length of tongue exclusive of tenon through front frame 2′-11″. Tongue braces a steel bar ½″x2″ attached to end of tongue by two bolts, and to corner of frame by one bolt and one wood screw. Steel plates ½″x3″x 18″ extending 6″ beyond end are bolted over and under tongue. A clevis hole 1¼″ diameter centered 2½″ from outer end of each plate. All bolts and wood screws are ½″ in diameter, in wood the bolts have square shanks and round heads; in iron, the head is replaced by a thread and a nut.

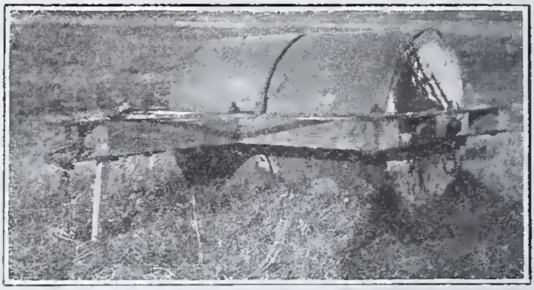

Fig. 4. Roller with wooden and steel frame. Two rolls each 21 inches long, 30 inches diameter, 20 gauge galvanized iron shell with shaft loose in roll. For details of frame see Fig. 5.

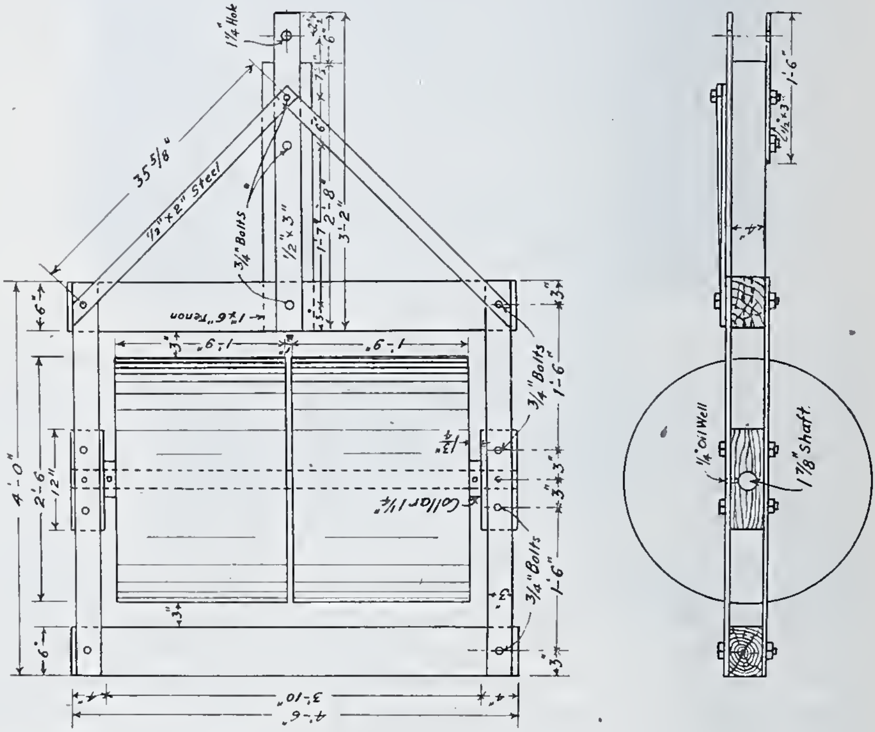

Fig. 5. Details of frame for roller shown in Fig. 4.

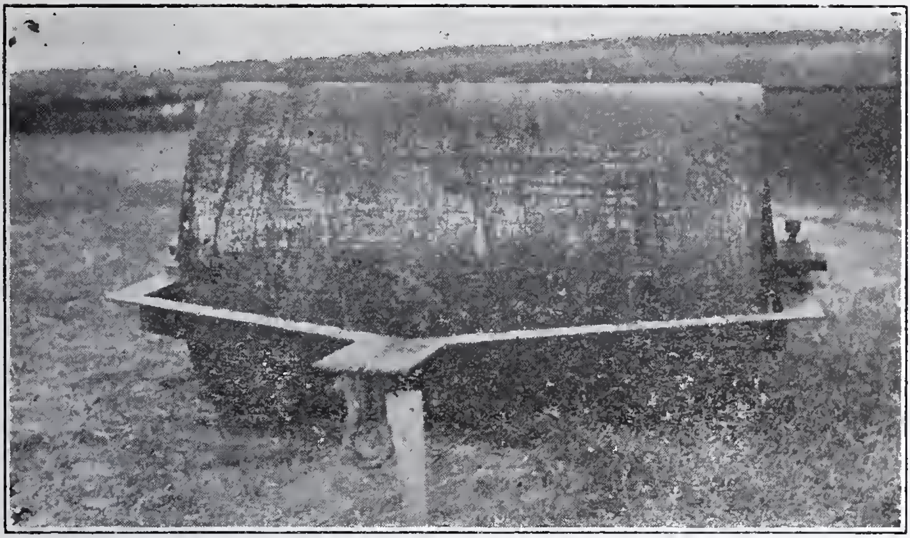

Fig. 6. Roller with steel frame. Roll 48 inches long, 30 inches diameter, 16 gauge sheet steel shell with shaft fixed in roll. Rollers of a type similar to this will be built and placed on the market for the season of 1924 by the Granite City Iron Works, St. Cloud, Minnesota.

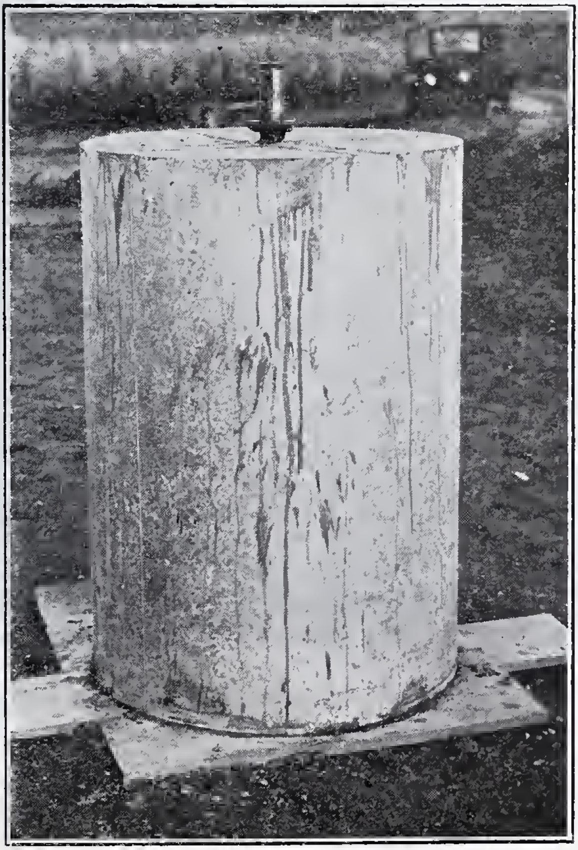

Fig. 7. Galvanized iron shell 42 inches long immediately after filling with concrete, shaft fixed in roll.

Fig. 8. Roller to cover a width of land equal to the distance between the outside edge of the rear wheels of a heavy tractor. Two rolls each 40 inches long, 30 inch diameter, ¼ inch boiler plate welded seam shell with 2⅞" shaft loose in rolls. Frame wood and steel with iron bearing blocks cast in two pieces. Four 8 inch hollow cylinders cast through each roll which decreases the weight 200 pounds per foot of roll length. Effective weight of this roller approximately 525 pounds per lineal foot.

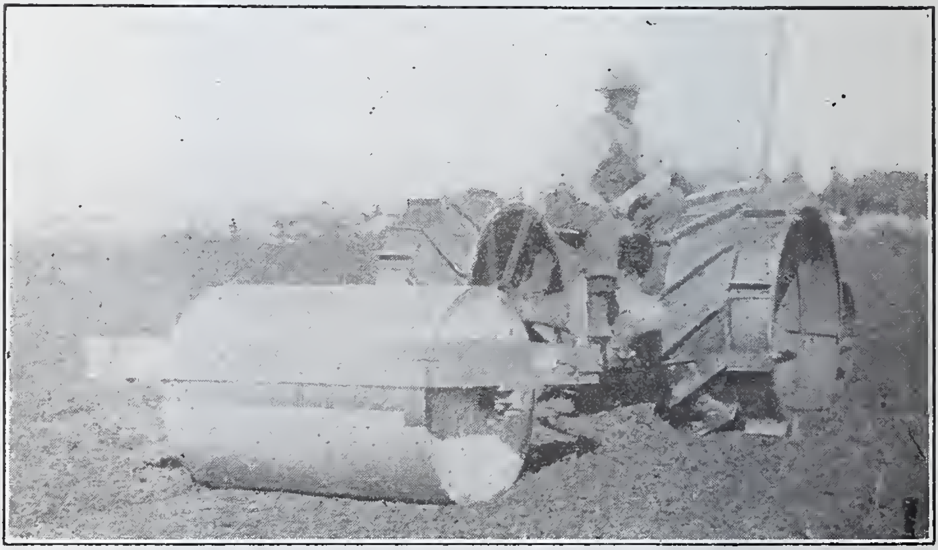

Fig. 9. Roller shown in Fig. 2 drawn by small tractor and operating on a freshly plowed peat field.

Consequently a 42 inch length of roll has been found convenient and satisfactory for either team or small tractor. If desired to pass the roller over the entire field when drawn by large tractors the roller may be made of sufficient length to cover the land between the outside edge of the rear tractor wheels.

Some of the rollers now in use have only one roll 42 inches in length. For ease in turning, convenience in transportation and use by either team or tractor a total cylinder length of 42 inches made up of two rolls each 21 inches long is recommended for ordinary farm conditions.

Shell of the Roll. The shell of the first roller was made of one-fourth inch boiler plate steel with a gas welded seam. Such a shell is expensive in first cost as it necessarily must be made in a boiler factory, but its life is almost unlimited. These rolls after eight years of service are as good as new. Some of the later rolls have been made of galvanized iron and sheet steel with a soldered seam, but none of them have been in use a sufficient length of time to determine their wearing qualities. The shell of rollers used exclusively on peat will undoubtedly wear much longer than on sand, and mineral soil or roads containing gravel will rapidly wear a thin shell. If sheet metal is used it is believed that it should not be less than 18 gauge, a 12 or 14 gauge being preferable. It is doubtful if galvanized iron has any advantages over sheet steel. The best grade of culvert metal would be more rust resistant than plain steel but would be considerably more expensive. Rollers with sheet metal shells have not been used for a sufficient length of time to determine the most economical gauge and quality of metal to be used. The shell should have a soldered or welded seam, be truly round and having centered within it a gas pipe with interior diameter one-eighth inch larger than the shaft. The pipe should be the same length as the roll, straight, reamed at the ends, clean on the inside and attached to the shell by metal straps which will hold it accurately in place until the shell is filled. The pipe center facilitates filling the roll, loading the filled roll on a wagon, replacing of the roll if damaged, using of a lighter roll and permits a slow motion of one end in turning. The end of the shell and pipe center should be square in order to permit the concrete filling to come flush with both and form an end surface at right angles to the rolling surface.

Filling Shell. The shell should be filled with a concrete mixture one part cement, 2 parts sand, 3 parts gravel. If screened sand and gravel are not available one part of cement should be used to three

parts bank run gravel. The mixture should be neither dry nor wet, but of a jelly like consistency, thoroughly tamped especially near the shell and pipe center. The filling of a 21 inch shell 30 inches in diameter will require 9 cubic feet of gravel, 6 cubic feet of sand, and 3 sacks of cement, or 9 cubic feet of sand and gravel as found in the natural bank and 3 sacks of cement. Preparatory to filling a smooth level floor or board platform with sufficient strength to bear the weight should be selected on which the shell can be placed on end. Approximately three and one-half hours are required to fill a 21 inch shell by a man who is somewhat familiar with mixing and placing concrete. After filling the roll should be protected from hot sun, dry wind and freezing temperature for five days, and should not be used for at least fifteen days.

Shaft. A cold rolled steel shaft one and seven-eighths inches in diameter has proven satisfactory in 42 inch rollers. The shaft should not be fixed by being cast in the roll, but held in place loosely by a collar and set screw inside of each bearing block and turn easily in the gas pipe center of the roll and the bearing blocks of the frame.

Length of shaft required for roller shown in Fig. 4.

2 rolls each 21 inches	42	inches
2 collars each 1¼ inches	2½	inches
2 bearing blocks each 4 inches	8	inches
Clearance between end frames	1½	inches
Total length	54	inches

Frame. The frame may be made of any design and material that will permit attachment of power and be sufficiently rigid to hold the bearings and permit the roll to turn. Several different types of frames are in use, workmen and material, available at time of construction, controlling, rather than design of frame. For type of all wood frame see (Fig. 2), wood and steel frame (Fig. 4), and all steel frame (Fig. 6). Type of frame shown in (Fig. 2) can be made by a carpenter and blacksmith; the angle-irons in the inside corners of the frames are prepared in a machine shop and might be difficult to secure in small towns. This frame could be simplified by using an oak timber 4 by 6 inches set edgewise for the end peices, a 2 inch hole in the center to serve as a bearing for the shaft, and a 2 inch mortise cut in each end to receive a corresponding tenon on each end of the side pieces. Each corner held together by two 1/2 inch bolts placed vertical. Figure 4 shows a

type of frame that can be made by a local carpenter and blacksmith, no machine work being required. Wood members of a frame should not be accuratelv cut or bored until iron parts have been fitted as lumber does not usually hold to the nominal dimensions. Where oak or maple bearings are used it is desirable to place on the inside of the bearing an iron plate one fourth inch thick and three and three quarters inches on the side. This plate should have a hole in center one eighth inch larger than the shaft diameter, and fastened to the bearing block by four two inch screws with ¼ inch shank, the plate being drilled and reamed to receive the screwheads. The most economical and desirable frame is the one made of steel (Fig. 6). This frame with the shell and shaft is built ready for filling in a machine shop. The Granite City Iron Works of St. Cloud, Minnesota, announce that they are prepared to fill orders for this equipment the coming season. So far as known to the writer the above is the only commercial firm that has attempted to place this roller ready for filling on the market.

If the roller is to be horse drawn, either a tongue or a disc harrow tongue truck should be attached to the stub tongue for the purpose of holding the frame in a horizontal position. Provision should also be made at the center of the rear frame for attaching a mowing machine or a disc harrow seat.

Cost. Since these rollers have not been standardized and produced commercially in the past no definite price can be quoted. The following information has been collected and will serve as a guide to the approximate cost:

Cost of galvanized iron shell 30 inches in diameter, 21 inches long with 2 inch gas pipe fixed in the center ready to fill with concrete:

20 gauge	$5.00
16 gauge	6.00
12 gauge	7.00
10 gauge	7.50

Sheet steel substituted for galvanized iron would lessen the cost of each gauge approximately 10 per cent.

Cost of filling shell 30 inches in diameter and 21 inches long:

3 sacks of cement	$2.10
9 cubic feet of gravel	.50
6 cubic feet of sand	.25
Labor 3½ hours	1.75
Total	$4.60

Complete cost of Roller shown in (Fig. 2).

Frame, shell and shaft ready for filling	$32.00
Freight and drayage	2.00
Filling 42 inch roll	9.20
Total	$43.20

Complete cost of Roller shown in (Fig. 4).

Shell, shaft and collars	$14.75
Frame, material and labor	25.40
Filling	9.20
Total	$49.35

Complete cost of Roller shown in (Fig. 6).

Frame, shell and shaft ready for filling	$32.00
Freight and drayage	2.00
Filling 42 inch roll	$9.20
Total	$43.20

The rollers shown in (Fig. 2 and 6) were made ready for filling in a shop and hauled to the farm where they were filled. The one shown in (Fig. 4) was assembled, framed and filled on the farm, the steel work being purchased and drilled at the blacksmith's shop in the nearest town.

Summary. A roller for use on peat land should weigh 700 to 800 pounds per lineal foot.

A roller 30 inches in diameter has proven satisfactory.

A rolling length of 42 inches is satisfactory for use by either team or small tractor.

Two short rolls are preferable to one long roll.

A shell made of ¼" boiler plate steel with welded seam is satisfactory from the standpoint of service.

Shells made of sheet metal have not been sufficiently tested to determine the most economical gauge and quality of metal for this purpose.

The shaft should be loose and not fixed in the roll.

The roll should be filled with a dense concrete of 1:2:3 mixture having a jellylike consistency and well tamped.

The filling of a 42" roller will require 18 cubic feet of screened gravel, 12 cubic feet of sand and 6 sacks of cement, or 18 cubic feet of bank run gravel, and 6 sacks of cement.

The frame may be made of wood, steel or a combination of wood and steel in a machine shop or by local workmen.

Special lengths and weights of rollers can be readily made if desired.

PEAT FUEL PROMOTION

By B. F. Haanel

In Charge Fuel Testing Division Canada Department of Mines

The American Peat Society as reorganized and constituted has two main objectives: The assisting of legitimate attempts to establish a peat industry and the discouragement of all attempts which can only result in failure. The society is actuated only by altruistic motives and is determined, so far as lies within its power, to eliminate those forces which in the past and up to the present, have retarded the development of the peat resources along sane, sound lines, and have shaken the confidence of the public and of capital in everything connected with peat.

Development of peat resources must take place in that direction which the nature of the particular bog, the surrounding conditions and the market and requirements for the product made, especially favour. To illustrate: certain peat bogs are especially valuable, and perhaps only valuable, for agricultural purposes; others are suitable only for the manufacture of a fuel; while some may be utilized to advantage for both.

The principal factors, therefore, governing the development of any particular bog are the extent of the bog, the quality and character of its contents, and the general physical characteristics of not only the bog but the surrounding country. The latter is of great importance since the drainage of a bog, especially if it is to be used for the manufacture of a fuel, is of great moment, and the cost of this depends on the physical conditions of the surrounding country. Other important factors are demand for and cost of disposing of products, whether these be agricultural or a fuel, and finally honest promotion and keen business management.

In the case of the development of a peat bog for the manufacture of a fuel many unfortunate attempts, some notorious, have been made which, on account of the employment of processes based on wrong principles, have resulted in absolute failure with the loss of capital invested and, what is perhaps of more serious moment, the loss of the

confidence of the public in any enterprise which has as its objective the development of peat resources for fuel purposes.

Failures of such attempts have been perhaps more numerous in Canada than in the United States because of the scarcity of fuel in certain portions of Canada but in both countries the causes for failures have been the same—ignorance and dishonesty. Sound financing in this case, is essential for the success of the enterprise as in any other commercial enterprise. To ignorance is due a large proportion of the failures, ignorance both on the part of investors, promotors and inventors. Ignorance has been capitalized and ignorant investors have been victimized by dishonest, unscrupulous promotors. These latter are responsible for a large amount of the money lost in peat ventures.

The Peat Society, as a body, wishes to be placed on record as stating emphatically and unreservedly that at the present time peat can not be economically dehydrated by: pressing, in either hydraulic, filter or other type of press; osmosis, electrical or otherwise; by artificial drying, no matter what type of dryer be employed; and that dehydrated peat, no matter how the water is removed, can not be economically carbonized and briquetted for the preparation of an industrial or domestic fuel. This Society, further, wishes to go on record as stating that at the present time the only economic process known for the manufacture of a fuel is the "Air-Dried-Machine Peat Process" which employs the heat of the sun for removal of the water content of the raw peat substance.

This and all other processes has been exhaustively investigated by the United States Geological Survey, Bureau of Mines, Fuel Research Board of Great Britain, and the Canadian Department of Mines, and recently by the Joint Peat Committee appointed by the Federal Government and the Government of the province of Ontario, Canada, and this society urges that the findings of these authorities be carefully considered, and their recommendations followed by all contemplating the manufacture of peat fuel or the investment of funds in peat projects both in this country and in Canada.

NEWS OF THE INDUSTRY AND THE SOCIETY

The following persons have recently become members of the society:

M. A. Garrett, 1021 Riverside Drive, South Bend, Indiana.
B-D-L Corporation, Fredonia, N. Y.
Leonard Brown, Box 72, Proctor, Minnesota.
C. C. Nelson, 518 Lutheran Aid Bldg., Appleton, Wisconsin.
University of Florida, Experiment Station, Gainesville, Florida.
Charles O. Harness, Hamlet, Indiana.
E. F. Gregory, Equitable Bldg., Tacoma, Washington.
Brown Company, Research Dept., Berlin, New Hampshire.
M. M. Barney, R. F. D. 2, Andover, N. Y.
Cherry Hill Nurseries, Cherry Hill St., West Newberry, Mass.
Charles B. Law, 2 Rector Street, New York, N. Y.
E. Masson, Deerwood, Minn.
Westlake Chemical Co., Inc., Westlake, La.

Dr. Frederick V. Coville, President of the society, has recently been spending much time in Florida.

Mr. B. F. Haanel, member of the Executive Committee is engaged in the completion of the final report of the Canadian Government peat committee on the Alfred experiment.

PEAT INVESTIGATIONS

W. W. Odell, fuel engineer, Department of the Interior, has commenced the study of peat as a fuel, and is spending some time at the Minneapolis experiment station of the Bureau of Mines, which is in the northern peat district. So far, the work has consisted of making preliminary studies as to the best methods of attacking the problem with the funds available. He has also been in Canada and Florida.

PROGRESS IN UTILIZATION OF AMERICAN PEATS AND MUCKS

By W. C. Pelton

A complete summary of the usefulness of peat and muck in American agriculture and industry; nothing less than that statement fully covers the program of the American Peat Society at its seventeenth annual meeting in Washington, December 6-8. There were three general topics, with men of national reputation to discuss each one. These three high lights of the meeting were the economics of muck land development, the use of arid and alkaline mucks for crop growing out of doors, and the improvement of muck deposits by artificial means so that they may be used as top dressings for lawns and gardens, as a source of organic nitrogen in commercial fertilizers, and to some extent as partial substitutes for stable manure.

A healthful note of conservatism was sounded by three speakers who touched upon muck land development. Dr. L. C. Corbett of the U. S. Department of Agriculture, Mr. W. C. Steenburg, who operates several thousand acres of muck land in Indiana and Wisconsin, and W. R. Beattie of U. S. Department of Agriculture, all discussed this point, each from a somewhat different angle. The opinion seemed to be that there has been too rapid a developmnt of large areas of black soil, and that for the present we ought to call a halt, except in the case of tracts that are exceptionally close to markets or which are blessed with cheap and abundant labor. Mr. Steenburg pointed out that all of the common muck land crops required by the entire nation could be grown on a small fraction of the black land that is available in the middle western states, and that no one is apt to profit by further development at the present time. As Dr. Corbett said, it is time we took account of our peat soils as natural resources, just as much resources as coal or oil. He recalled the fact, too, that a bog undrained is gaining in organic matter every year, while as soon as the water is removed and the plow put to work, the organic matter begins to pass away, even though the operator does not make any money from his venture.

Significant comparisons were made by several speakers between the comparative profits of large scale and of small scale muck land farming. Large scale operation, it was pointed out, tends to lose in cost of labor what it gains by power methods of working the land. The

small farmer, especially if he is foreign born, works fifteen or eighteen hours a day, while hired hands insist on a maximum of ten or less.

However one might have felt after hearing of the difficulties and dangers of muck land farming, he learned that there are profits as well as discouragments in this field. Mr. J. N. Hoff, the well known operator of muck land in Great Meadow, N. J., gave a brief but meaty talk on his methods of growing celery and other muck crops. The soil of Great Meadows needs no lime, but Mr. Hoff insisted that raw muck should receive at least ten tons of manure to the acre, and he said that such a dressing, or perhaps a lighter one, every four years is usually profitable. In his experience one-half to three-fourths ton of 2-8-10 fertilizer, with nitrogen half and half sulfate of ammonia and tankage, gives the best results. Whether Mr. Hoff's ideas are worth studying may be judged from the fact that he took in $3,000 worth of salable crops per acre of land in 1923, and grew also a catch crop which paid all expenses of fertilizer and crop production for the entire season. His rule in marketing is to give the customer what he wants, packed as he wants it; but he also tries to excel in quality, uniformity, and pack.

While the Great Meadows muck, and many of those in the middle West, do not need much lime, others are strongly acid and must be heavily limed if used for truck crops. Dr. Frederick V. Coville, of the U. S. Department of Agriculture, was called upon to tell what crops could be grown on sour soils without liming. Dr. Coville described his studies of acid resistant crops, including blueberries and a large number of ornamental plants, some cultivated, like the rhododendron and azalea, and others at present wild but promising great utility as florists' stock. Among the latter is the familiar trailing arbutus which Dr. Coville has grown in wonderful perfection by providing soil of the right degree of acidity. Dr. Coville also demonstrated a field apparatus, devised by an associate in the Department, for determining quickly the acidity of soils by the hydrogenion method.

The important distinction between acid and alkaline soil was emphasized again and again. For example, the use of dried peat as a top dressing for grass on golf courses was described by Mr. T. H. Riggs Miller, of Flushing, L. I. His first experience was concerned with a promising type of peat which, when applied to grass, killed everything in sight. This was found to show a very high lime requirement. When alkaline peats were used grass grew amazingly. Peat composted with manure and sand, one-half peat or humus, one-quarter each sifted man-

ure and sand, has given best results for putting greens, which must bear dense grass with no weeds. Mr. Miller pointed out the absence of weed seeds in peat as compared to manure. This quality of the commercial peats recommends them for other purposes than lawn making.

The prospects of the commercial use of dried peat for fuel in the near future are not bright, according to B. F. Haanel, of the Deparment of Mines, Ottawa, Canada, who gave in much detail an account of the experiments of his department in trying to dry peat economically. He said the peats most valuable for fuel were generally the hardest to make dry enough for use, and that sometimes it would be necessary to use more than the fuel value of the peat to drive off the water. He and others agreed that in localities far from coal and wood, where peat may be dug cheaply, and dried in the open air, peat may well be used for house heating.

Dr. T. F. Manns, of the University of Delaware, reported on the progress he has made in releasing the nitrogen of peat, and in inoculating it with the bacteria that are necessary before the nitrogen can be made available. Some peats contain as much as three per cent of nitrogen, according to Dr. Manns, and such material will ultimately be used as an ingredient in fertilizers of the lower grades, when the nitrogen can be loosened from the organic compounds of which it is a part. It is said that the manure found indispensable on new muck is necessary not only because it introduces useful bacteria, but because it at the same time furnishes raw material, in the form of the strawey parts of the manure, which makes rapid bacterial growth possible. Gradually we are finding out the truths about manure.

It was somewhat of a climax at the meeting when the chairman announced that the American Peat Society plans to start an information bureau for the benfit of its members, from which bureau they may get expert advice on any of their business problems. It looks like a good time for more muck land truckers to lineup with this society.—Market Growers' Journal Jan. 15, 1924.

Pointing out that the number of abandoned farms throughout the United States is increasing rapidly due chiefly to the progressive impoverishment of the land and the mounting cost of fertilization, a statement issued by the North Carolina Geological and Economic Survey

asserts that one of the remedies for this condition is to be found in the peat and muck bogs,

These peat deposits, the survey declares, are among the few domestic sources of nitrogen that can be converted economically into plant food and that can be applied to revitalize exhausted farm land.

—Washington, D. C. Times, March 5, 1924.

A consulting chemical engineer representing one of the nation's more impoitant chemical corporations recently has been in the Fellsmere section of Florida investigating the posibilities of the peat and deposits. These deposits are said to be rich with ammoniates and the prediction is made that the American farmer will be benefited by their development.

The chemical concern is erecting a $250,000 plant, which is expected to produce 150,000 tons of marketable material annually.

—Jacksonville Times, February 14, 1924.

The Trans Florida Central Railroad Company will be organized to acquire the Fellsmere Railway and extend it ten miles to a connection with the Florida East Coast Railway at Sebastion, in order to provide facilities for the Standard Agricultural Chemical Corporation's proposed fertilizer works here, this New York corporation having announced recently its intention to locate here a plant with annual output of 150,000 tons of fertilizer manufactured from extensive peat deposit.

—N. Y. Jour. Commerce, Feb. 18, 1924.

AMERICAN PEAT SOCIETY

OFFICERS

JOURNAL OF THE AMERICAN PEAT SOCIETY

BOARD OF COUNCILLORS

ADVISORY AND RESEARCH COMMITTEE

Address communications for committee to J. H. Beattie, McLean, Virginia.

SCOPE AND PURPOSE OF SOCIETY

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. It is an organization devoted to research and to the dissemination of information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat and muck.

Through its Advisory and Research Committee, consisting of botanists, geologists, chemists, bacteriologists, and engineers, the society will answer inquiries from members relating to the use of their deposits. There is no charge for general service.

NATURE AND USES OF PEAT AND MUCK

Peat and muck are residues resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas covered or saturated with water. They may be identified as the dark-colored soils found in bogs and swamps and in other low places. The commercial uses of peat and muck are varied. In the United States they are utilized chiefly as crop soils, as soil conditioners, and as ingredients of fertilizers. In some of the countries of Europe peat is used for fuel and is the basis for small manufacturing industries. Gas, charcoal, coke, and some by-products are produced in small quantities. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of litter, packing material and rugs, and selected varieties of peat moss have been used to make surgical dressings.

ECONOMIC ASPECTS OF PEAT

The United States contains over 12,000 square miles of undrained peat and muck land. The average deposit, if used for industrial purposes, will yield 200 tons per acre-foot. It is estimated that the deposits would be capable of yielding about 14 billion short tons of air-dried peat. Peat and muck areas are distributed throughout the Great Lake, Pacific Coast, and Atlantic Coast States. Peat and muck in Canada cover 37,000 square miles. According to published statistics, European countries annually consume about 50 million tons of peat fuel.

MEMBERSHIP

Present membership of the American Peat Society consists largely of agriculturists, engineers, and peat and muck land owners and producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetable matter, and in the production of fuel or generation of power, may join. Applications should be addressed to the secretary. Membership and subscription to the Journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS

Meetings of the Society are held annually in important cities throughout the peat regions. Papers are presented relating to the subjects enumerated. A quarterly journal, containing the proceedings of the Society, papers concerning all phases of peat, muck, and allied subjects and news of the industry, is published and sent to members. The scope of the papers is very broad, including the location of deposits, drainage and reclamation problems, methods of cultivation, fertilizer requirements, crop adaptation, cultural practice, physical and chemical characteristics, engineering practice, and production methods. One of the principal objects of the Society is the exposition of extravagant claims made by promoters.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society.

(Date)

Mr. Charles Knap, *Secretary-Treasurer,*
American Peat Society,
2 Rector St.,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This action is prompted by my interest in the science and utilization of peat and muck and the welfare of the society.

Yours very truly,

(Signature)

(Address)

CONTENTS

PAST PRESIDENTS
OF THE AMERICAN PEAT SOCIETY

DR. JOSEPH HYDE PRATT,
State Geologist of North Carolina,
Chapel Hill, N. C.

DR. EUGENE HAANEL,
Director Department of Mines,
Ottawa, Ontario, Canada.

PROFESSOR PETER CHRISTIANSEN,
Professor of Metallurgy, School of
Mines University of Minnesota.
Minneapolis, Minn.

JOHN N. HOFF,
2 Rector St.,
New York, N. Y.

L. B. ARNOLD,
Duluth, Minn.

PROFESSOR HOMER C. THOMPSON,
In Charge Department of
Vegetable Gardening
Cornell University,
Ithaca, N. Y.

PROFESSOR A. C. WHITSON,
Professor of Soils,
In Charge Agricultural Experiment Station,
Madison, Wis.

MYRON W. ROBINSON
New York, N. Y.

Manuscripts sent for consideration by the editor should be registered. Written discussions of papers are invited. Authors wishing reprints of articles are requested to correspond with the editor. Advertising rates will be furnished upon application to the secretary.

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Journal of the American Peat Society

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NEWS OF THE SOCIETY

Eighteenth Annual Convention to be Held in Minnesota.

The Executive Committee of the American Peat Society has decided to hold the eighteenth annual convention in Minnesota September 15, 16, 17, and 18, under the direction of Dr. F. J. Alway, of the State University, in co-operation with the experimental stations of other States. There were many reasons why the Committee favored that State. There is more muck and peat in Minnesota than in any other State, and, more activity in its development than elsewhere. Dr. Alway has the confidence and respect of the owners of this land and of the agriculturists and engineers throughout the entire peat regions; he has done some excellent original experimental work, and is a frequent contributor to the Journal. Minnesota is centrally located and probably within easy reach of more of our members than any other important peat State in the country.

The following are Dr. Alway's tentative plans:

It is proposed that the convention begin at Albert Lea with the inspection of the fields and the whole development project of the Albert Lea Farms Company. A paper or two could be read while members are there. Members would then drive from Hollandale near Albert Lea to the Twin Cities Monday afternoon, so as to be at the University of Minnesota not later than nine o'clock Tuesday, where a program devoted to the industrial side of peat could be held. The Engineering Experiment Station has been investigating the fuel and power possibilities of peat during the past three years, special appropriations having been made by the Minnesota State Legislature. Probably the forenoon would suffice for the papers on the industrial

side and the inspection of the equipment used in the investigations at the Mines Experimental Station.

Tuesday afternoon a visit could be made to the Coon Creek Experimental Fields and the rather extensive peat farms in Anoka County, spending the night at the Twin Cities. Wednesday members could drive from the Twin Cities to Grand Rapids, visiting the low lime peat experimental field near Milaca, then driving past Lake Mille Lacs, through Aitkin to Grand Rapids. Thursday a drive could be made to Meadowlands and either Fens or Duluth. Papers not given at Albert Lea or Minneapolis could be delivered en route. This plan contemplates the furnishing of sufficient automobiles to provide free transportation for guests.

Mr. L. B. Arnold, of Duluth, suggests that, instead of spending Wednesday night at Grand Rapids it be spent at Hibbing, which would give the members of the party an opportunity to see what he reports to be the richest village on earth, the largest iron mines on earth, and a very comfortable hotel to stop in. He suggests we could then drive from Hibbing the following morning through Fens, Meadowlands, and into Duluth.

Dr. Alway's program would give the members a wonderful opportunity to see some of the foremost peat-development projects in the United States and a most delightful automobile trip in addition. Mr. Arnold says that much of the country is attractive and for those who wish to do a little fishing they will try to deliver the goods.

It has been suggested that this trip might involve a little too much traveling, in which event the meeting might begin at Hollandale and be resumed at Minneapolis, including a trip to Coon Creek and the other peat lands of Anoka County.

Further progress of the plans of the convention will be communicated to members of the Society by means of circular letters.

Mr. Arnold Becomes Member of the Board of Councillors

The name of Mr. L. B. Arnold, of Duluth, Minnesota, has just been added to the Board of Councillors of this Society. Mr. Arnold was at one time president of the American Peat Society, and he is actively interested in its work. Through him the Society is in receipt of $200 for the advancement of the science. In transmitting his acceptance, Mr. Arnold expressed appreciation of the work the Society

is doing, and stated that he would be very glad to do anything which he could to help in the work being carried on by the American Peat Society. He expressed particular appreciation of the value of the Advisory and Research Committee, and said that he felt it was going to make the Journal and the Society felt more than ever. He complimented particularly the peat-development work being carried on under the direction of Dr. F. J. Alway.

Meeting of the Research and Advisory Committee.

The Committee held a meeting at the Cosmos Club, Washington, D. C., on May 28. The Chairman, Dr. F. V. Coville, presided. Dr. David White, Chief Geologist U. S. Geological Survey; Dr. D. A. Lyons and Messrs. R. H. Kudlich and W. W. Odell of the Bureau of Mines; Dr. L. C. Corbett and Messrs. C. S. Scofield, W. R. Beattie and J. H. Beattie of the Bureau of Plant Industry, U. S. Department of Agriculture, were present.

The following had been proposed as a tentative outline for discussion by the Committee:

1. That the Committee devise ways and means whereby it can be of the greatest possible service to the muck and peat industry in all its phases, this to be accomplished by giving inquirers the benefits of the advice and experience of the individuals making up the Committee.
2. To devise methods for the closer co-operation between Federal agencies carrying on work on the various phases of peat utilization.
3. To work out plans for co-operative muck and peat work between the Society and the several state institutions located in sections where muck and peat problems are of vital inportance.

It was agreed that the methods now being followed, that is the referring of inquirers to every member of the Committee who is in a position to give advice and assistance on any special phase of the problem is as good as can be devised. A bibliography of muck and peat literature is being prepared by the Committee, and this will be published for the benefit of all interested persons, and will be a distinct help in making available all information on the many complex

problems involved in the agricultural and industrial utilization of muck and peat.

Proposition Number 2 was discussed at length and it was agreed that the best method of procedure would be to have the various agencies in the Department of Interior and the Department of Agriculture give the Committee brief outlines of their present and prospective activities in order that plans for closer co-operation may be worked out and suggested to the proper officials of these Departments. It was agreed that another meeting of the Committee be called as soon as this information is available.

On account of lack of time no study was given to the suggestion that plans be made for active co-operative work between the Society and the various state agencies in muck regions. This will be taken up at a later meeting.

It is the desire of the Committee that every member of the Society feel that the Committee wishes to extend the fullest help, and suggestions are always welcome.

J. H. Beattie.

POSSIBILITIES AND LIMITATIONS OF BACTERIZED PEAT [1]

By Thomas F. Manns

Plant Pathologist and Soil Bacteriologist, University of Delaware.

The question that we are interested in is, what value has the organic matter and nitrogen of peat?

Let me say at the beginning of this discussion that there has not been enough exacting research upon peat either as a fertilizer or as a soil improver. The data which I wish to present is taken from research done at the Ohio and Delaware Experiment Stations.

It is not necessary to tell you that organic matter rapidly decays and disappears in the soil; that there is a process at work in all arable soils which rapidly breaks down and oxidizes the constituents of organic matter, and it disappears. So rapid is this process in all temperate regions where the rainfall is 35 inches or over, that the yearly crop of grass, foliage, stems and roots, soon decays and is reduced or oxidized almost as fast as it falls. In regions of such rainfall (35 inches or over) the only exception to this rapid decay is to be found in bogs or peat areas in which decay or oxidation is retarded by lack of aeration; that is, by a shortage of oxygen, which retards oxidation. Such regions are flooded a great part of the year.

In more arid regions, that is where the rainfall is less than 25 inches during the warm or growing season, there is usually an incomplete destruction of the organic matter; hence there is an accumulation of organic matter. Such a region is to be found in the prairie states known as the spring wheat states of the northwest.

The next question I wish to raise is what value has organic matter as a fertilizer. I think some data gathered at the Ohio Experiment Station in their well-known three year rotation, answers that question pretty well. Table I, in which these data are presented, shows that the great value of manure is not the nitrogen it con-

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[1]Paper read before convention of the American Peat Society December 7, 1923, at Washington, D. C.

tains; its value lies in the stimulation of, that is feeding of, the nitrogen fixing bacteria, the group of organisms we call the azotofiers.

TABLE I

Quantity and Source of Nitrogen Furnished by Bacteria to Crops in the Ohio Corn, Wheat and Clover Rotation

(A) 12 Year Average Crop Yields and Nitrogen Removed

Plot Treatment	Corn 12 yr. average		Wheat 12 yr. average		Hay 9 yr. ave.	Nitrogen removed in 3 crops
	Grain	Stover	Grain	Straw		
3 Stall man. 8 T. plus 120 lbs. pk. phos.	63.3 Bu.	1.78 T.	27.0 Bu.	1.46 T.	2.38 T.	239.4 lb.
4 None (Check)	31.0 Bu.	1.01 T.	11.2 Bu.	.65 T.	1.02 T.	110.2 lb.

(B) Source of Nitrogen and Amount Added by Bacteria in each Rotation of Three Years

	Plot 3	Plot 4
Nitrogen removed in three crops	239.4 lbs.	110.2 lbs.
Nitrogen added in three crops (8 tons of manure 80 lbs. from air 9 lbs.)	89.0 lbs.	9.0 lbs.
Nitrogen added by soil bacteria	150.4 lbs.	101.2 lbs.
Nitrogen added by clover nodule bacteria	63.4 lbs.	27.2 lbs.
Nitrogen added by azotobacters	87.0 lbs.	74.0 lbs.

(C) Amount of Nitrogen in Plots 3 and 4 at Beginning of Experiments and After 12 Years

	Plot 3	Plot 4
Amount of nitrogen in 1894	2016 lbs.	2016 lbs.
Amount of nitrogen in 1907	2060 lbs.	1810 lbs.
Gain or loss of nitrogen in 12 years	44 lbs. G.	–206 loss
Nitrogen removed in crops in 12 years	957.6 lbs.	440.8 lbs.
Total nitrogen gained in 12 years	1001.6 lbs.	234.8 lbs.
Total nitrogen added by air and manure in 12 years	356.0 lbs.	36.0 lbs.
Total nitrogen gained by soil bacteria	645.6 lbs.	198.8 lbs.

(D) Amount of Nitrogen in Each Crop (12 Yr. Ave.)

	Plot 3	Plot 4
Corn, including grain and stover	91.8 lbs.	47.2 lbs.
Wheat, including grain and straw	52.4 lbs.	22.2 lbs.
Clover—hay crop	95.2 lbs.	40.8 lbs.

(E) Amount of Nitrogen in Crop Product

Corn—1 bushel grain has 1 lb. nitrogen
Corn—1 ton of stover has 16 lb. nitrogen
Wheat—1 bushel grain has 1.4 lb. nitrogen
Wheat—1 ton of straw has 10.0 lb. nitrogen
Clover—1 ton hay has 40.0 lb. nitrogen
Manure—1 ton, stall has 10.0 lb. nitrogen

[1]Tables A, B, C and D were compiled by using the data in E

Studying this table briefly we see that on plot 3 in this three year rotation, in which 8 tons of manure and 120 lbs. of rock phosphate is applied, we have actually added only 80 lbs. of nitrogen in manure and nine pounds is added by rain water from the air, a total of 89 lbs., and during this same time we have taken away from this plot in corn, wheat, clover, hay, wheat straw, and corn fodder, 239.4 lbs. of nitrogen. What we are interested in is, from what source does all this increased amount of nitrogen come? There is only one possible source and that is the air, and to get this from the air in agri-

cultural practice means one of two methods, either by growing legumes that stimulate the symbiotic nitrogen fixing group, popularly known as the nodule or root bacteria, or feeding the nonsymbiotic group of nitrogen fixing bacteria in the soil; that is, the group of bacteria which are able to fix nitrogen from the air without working in the root nodules, a group scientifically known as the azotofiers. Whether these bacteria work symbiotically living with legumes or work non-symbiotically living on organic matter in the soil, they are both azotofiers, fixing atmospheric nitrogen. The farmer adds manure to the soil and unconsciously feeds the nitrogen fixing group of bacteria; he often takes from the soil three to ten times as much nitrogen as he adds, and wonders why fertility is depleted.

The mathematics of soil fertility, that is, the income and outgo of fertility, is just as exacting as is the profits and losses, the assets and liabilities of any commercial enterprise. Now, one of the things I am interested in is to show you that the value of manure is not its nitrogenous matter, though this has much value, but its cellulose or non-nitrogenous matter which feeds the nonsymbiotic bacteria in the soil that fix atmospheric nitrogen.

Looking again at Table I, under (B), we note that of the 239.4 lbs. of nitrogen removed in the crops of the rotation from plot 3, (this data is on an acre basis) that 150.4 lbs. were added by soil bacteria, and granting that the clover crop added 2-3 of its nitrogen through the nodule organisms, then 87 lbs. of nitrogen came from the nonsymbiotic nitrogen fixing bacteria in the soil that live independently of legumes.

Granting that the non-nitrogenous matter of manure is even more important than the nitrogenous matter, does this relationship hold true for peat? What value has the nitrogen of peat? In compiling the data in Table I of the Ohio corn-wheat-clover rotation, we simply credited the nitrogen of the manure, viz., 80 lbs., as contributed to the amount taken away by the crop, when as a matter of fact we know that only a part of the nitrogen in the manure was made available to the crop; probably not more than 50%. Thus, of course, we must credit just that much more to the soil organisms living on the organic matter in the soil.

American agricultural experiment stations have been very slow in undertaking research upon muck. The Swedish Peat Society has carried on experimental work for 25 years or more. I am pleased to

see that the Michigan Agricultural College has outlined plans for fertility studies on muck soils. Prof. Harmer, in the December (1923) number of the "The Michigan Agriculturist" Vol. 3, outlines their fertilizing program for studies of muck soil. After noting that applications of potash and phosphorus in most cases gave economic increases, he says, "Nitrate was unnecessary for most crops on the deep high-lime mucks, but gave paying increases on the shallow high-lime and on the low-lime mucks."

My first interest in muck soils was at the Ohio Experiment Station, and I wish to review some experiments carried out with muck while connected with that station.

The work at the Ohio Experiment Station was done in 1911 and contemplated several lines of investigation in which the nitrogen and organic matter of peat were concerned.

The first investigation was headed, "Ammonification as Influenced by Organic Fertilizers." In this work, a comparison was made with peat, dried blood, cotton seed meal and sheep manure.

TABLE II

AMMONIFICATION OF NITROGEN IN DIFFERENT ORGANIC MATERIALS

	Per cent of nitrogen	Per cent of nitrogen available by MgO method	Per cent of nitrogen available after 8 days ammonification in soil[2]
Peat	2.47	.97	.245
Dried blood	12.46	1.01	22.265
Cotton seed meal	5.96	1.63	32.645
Sheep manure	2.35	1.43	1.390

[2]Average of four different soils

From the work we see that the nitrogen from peat and manure is much more slowly available than that from dried blood or cotton seed meal.

The next question we raised was the availability of peat nitrogen as compared with that from other organic materials when measured by chemical methods.

TABLE III

Availability of Nitrogen by the Alkaline Potassium Permanganate Method and the MgO Method

	Alkaline Potassium Permanganate	MgO Method
Peat	24.9%	.96%
Peat heated 1 hr. at 200° G	27.0%	
Peat heated 1 hr. at 200° C	20.5%[3]	
Dried Blood	78.6%	1.01%
Cotton seed meal	49.2%	1.63%
Sheep manure	39.6%	1.43%

[3] Loss of Nitrogen here indicates that some of the peat was carbonized

The next study took up the feasibility of treating peat with different chemicals, such as sulphuric acid, commercial acid phosphate and lime; and by such treatments, increase the nitrogen which may be ammonified in soil in eight days.

The following treatments were given and the treated organic matter given 8 days ammonification in soil.

Exp. 1 and 2	Nothing added.
Exp. 3 and 4	5.47 grams of peat.
Exp. 5 and 6	.8026 grams of dried blood.
Exp. 7 and 8	1.6767 grams of cotton seed meal.
Exp. 9 and 10	2½ grams of sheep manure.
Exp. 11 and 12	5.47 grams of peat, 1 gram of sulphuric acid, 4.47cc of water; stood 24 hours then neutralized with CaO.
Exp. 13 and 14	5.47 grams of peat, 5.47 grams of sulphuric acid, 2cc of water; stood 24 hours then neutralized with CaO.
Exp. 15 and 16	5.47 grams of peat, 5.47 grams of acid phosphate, 5cc of water; stood 24 hours then neutralized with CaO.
Exp. 17 and 18	5.47 grams of peat, 1 gram of acid phosphate, 6cc of water; stood 24 hours then neutralized with CaO.
Exp. 19 and 20	5.47 grams of peat, 1 gram of sulphuric acid, 4.27cc of water; stood 5 days then neutralized with CaO.

Exp. 21 and 22	5.47 grams of peat, 5.47 grams of sulphuric acid, 5cc of water; stood 5 days then neutralized with CaO.
Exp. 23 and 24	5.47 grams of peat, 5.47 grams of acid phosphate, 6cc of water; stood 5 days then neutralized with CaO.
Exp. 25 and 26	5.47 grams of peat, 1 gram of acid phosphate, 6cc of water; stood 5 days then neutralized with CaO.
Exp. 27 and 28	5.47 grams of peat, 5.47 grams of CaO, 16cc of water; stood one day then neutralized with sulphuric acid and 18cc of water.
Exp. 29 and 30	5.47 grams of peat, 5.47 grams of CaOH, 11cc of water; stood one day then neutralized with sulphuric acid and 19cc of water.
Exp. 31 and 32	5.47 grams of peat, 5.47 grams of CaO CaOH (?) 16cc of water; stood 5 days then neutralized with sulphuric acid and 18cc of water.
Exp. 33 and 34	5.47 grams of peat, 5.47 grams of CaO, 11cc of water; stood 5 days then neutralized with sulphuric acid and 19cc of water.

TABLE IV

SUMMARY OF AMMONIFICATION RESULTS FROM ABOVE TREATMENTS ON PEAT AND OTHER ORGANIC FERTILIZERS

Number of Experiment	Grams of nitrogen available as NH_3	Grams of nitrogen available, average of Dup. Exp's.	Grams of nitrogen available as NH from that added	Per cent of the nitrogen made available as NH_3
1	.00280			
2	.00266	.00273		
3	.00630			
4	.00630	.00630	.00357	2.48
5	.05054			
6	.04704	.04979	.04606	46.06
7	.04802			
8	.04662	.04732	.04459	44.59

9	.00420			
10	.00378	.00399	.00126	2.13
11	.00686			
12	.00910	.00798	.00525	3.64
13	.01274			
14	.01246	.01260	.00987	6.85
15	.00686			
16	.00672	.00679	.00406	2.82
17	.00700			
18	.00700	.00700	.00427	2.97
19	.00630			
20	.00770	.00700	.00427	2.97
21	.01190			
22	.01190	.01190	.00917	6.36
23	.00490			
24	.00476	.00483	.00210	1.45
25	.00476			
26	.00448	.00462	.00289	2.00
27	.02226			
28	.01386	.01806	.01533	10.64
29	.03346			
30	Lost	.03346	.03073	21.34
31	.01260			
32	.02260	.01760	.01487	10.32
33	.01918			
34	.02632	.02275	.02002	13.9

In Table IV we see at a glance that ammonification took place in all the treatments in excess of the untreated soil. In this work the soil, after receiving the various applications, was placed in an incubator and kept at 26 degrees C. for eight days. The optimum moisture content was maintained as nearly as could be determined. About 15cc of bacterial infusion was added to each flask; this infusion was made by taking 1000 grams of fresh soil and adding to the same 1000cc of water.

It is quite apparent that the various treatments given the peat (with the exceptions of 23 and 24, 25 and 26) more or less hastened

the availability, the nitrogen being influenced up to 21.34%. It is interesting to find the greatest per cent of availability in peat treated first with lime, and then neutralized with sulphuric acid. The longer the lime acted the less nitrogen was found as ammonia. This is shown by comparing experiments 29 and 30 in which the peat was treated with hydrate of lime 1 day and 21.34% of the nitrogen was made available with Experiment 33 and 34 in which the peat was treated with hydrate lime 5 days when only 13.90% of the nitrogen was made available. It is difficult to understand why peat treated first with strong acid, then followed by neutralization with lime (Experiments 13 and 14) should not make more nitrogen available than first treating with lime. (Experiments 28 and 34).

Another series of experiments was run to show the influence of high temperature and steam pressure on peat nitrogen. In this series, peat variously treated with lime, sulfuric acid and commercial acid phosphate was given steam pressure treatments of 20 lbs. for one-half hour, and comparisons were made with dry heats at 200 to 250°C from one-half hour to one hour.

Table V shows the treatments given and the per cent of nitrogen available as ammonia.

TABLE V

Exp. No.	Treatments	Per cent of nitrogen Available
1	3 grams peat + 1cc H_2SO_4—stood 1 hour	3.0
2	3 grams peat + 2cc H_2SO_4—Stood 1 hour	1.4
3	3 grams peat Steamed at 20 lbs. pressure ½ hour	1.2
4	3 grams peat + 3 grams CaO then steamed at 20 lbs. ½ hour; Neutralized with 2.8 H_2SO_4 + 1 $CaCO_3$	.1
5	3 grams peat + 2.8 grams H_2SO_4, then steamed at 20 lbs. for ½ hour; neutralized 3 grams CaO + 1 gram $CaCO_3$	15.5
6	3 grams peat heated at 250°C 1 hour	3.5

7	3 grams peat + 1 gram CaO, slightly moistened, then heated 250°C 1 hour	.7
8	3 grams peat + 3 grams acid phosphate then steamed at 20 lbs. ½ hour	1.6
9	3 grams peat + 2.8cc H_2SO_4 heated to 250°C ½ hr., then + 15cc H_2O +3 grams CaO	48.3
10	3 grams peat (Check)	.9
11	3 grams peat (100 mesh) + 2cc H_2SO_4 + 2½cc H_2O at 200°C one-half hour dry heat	21.6
12	3 grams peat (100 mesh) + 1cc H_2SO_4 + 3½cc H_2O at 200°C one-half hour dry heat	16.5
13	3 grams peat (100 mesh) + ½cc H_2SO_4 + 4½cc H_2O at 200°C one-half hour dry heat	12.7
14	3 grams peat (100 mesh) not heated or treated (check)	2.4
15	3 grams peat (100 mesh) + 2cc H_2SO_4 and 4½cc H_2O steamed at 20 lbs. one-half hour	13.8
16	3 grams peat (100 mesh) + 1cc H_2SO_4 and 2½cc H_2O heated 1 hour at 200°C dry heat	26.04
17	3 grams peat (100 mesh) + 1cc H_2SO_4 and 3½cc H_2O heated 1 hour at 200°C dry heat	26.04
18	3 grams peat (100 mesh) + ½cc H_2SO_4 & 4½cc H_2O heated 1 hour at 200°C dry heat	18.4
19	3 grams peat (100 mesh) + 3 grams acid phos. steamed at 20 lbs. ½hr.	1.4

From this work it is quite evident that dry heat at 200°C is much more effective in changing the nitrogen of acidulated peat to ammonium sulphate than is the steam pressure at 20 lbs.

Further, it is quite evident in this work that ammonification as measured chemically does not indicate to what extent ammonification will take place from these treatments, when the peat has been applied to soils with a responsive flora. Peat treated with CaO, shows prac-

tically no increase in ammonia availability by the MgO method and the alkaline-permanganate method over the untreated, but when the peat treated with CaO is placed in the soil the flora is able to considerably influence the nitrogen availability by ammonification.

Production of Glucose by the Acid Treatment

From two to four per cent of the weight of the peat was converted to glucose by the various steam and dry heat treatments when the peat was treated with the weaker amounts of acid.

Summarizing the chemical and biological studies on peat it is very evident:

1. The biological process of nitrogen fixation is of far reaching importance in maintaining the nitrogen supply in soils.

2. The carbohydrates of organic fertilizers are of much importance in furthering the process of nitrogen fixation.

3. Untreated or raw peat is rather slowly available, both from the standpoints of the carbohydrates for food for the nitrogen fixing bacteria, and the nitrogen through the process of ammonification.

4. The nitrogen of dried blood and cotton seed meal is more readily changed by ammonification, so that in 8 days in the soil about 50% may be obtained as ammonia by the MgO method; this is not true, however, with peat and sheep manure, in both of which the nitrogen ammonifies very slowly.

5. Ammonification of peat nitrogen biologically may be influenced by treatment with caustic (CaO) lime or hydrate lime, when followed by neutralization with sulphuric acid. (see Exps. 27 to 34 and summary of same.)

6. When peat, treated with sulphuric acid (Exp. 5 Table V) has been placed under steam pressure at 20 lbs. for one-half hour, then neutralized with CaO, 15.5% of the nitrogen becomes available as NH_3 after undergoing the action of soil organisms for 8 days.

7. Chemically, peat treated with sulphuric acid under dry heat at from 200 to 250 degrees C. for one-half hour showed much more nitrogen changed to ammonium sulphate than when treated in moist heat at 20 lbs. pressure for one-half hour. (Compare Exp. 5 Table

V with Exp. 9.) For acid treated peat under 20 lbs. pressure the NH_3 availability was 15.5% while the acid treated peat under dry heat at 250 degrees C. was 48.3%.

8. This work would seem to indicate that peat may have some commercial value as a fertilizer when properly treated.

Compost Studies with Peat

This is a review of Delaware Bulletin No. 115. I can do no better than to quote directly from this bulletin beginning page 3.

"The object of these investigations was to determine (1) whether high grade muck or so-called 'humus,' such as that found in the trucking district in northern New Jersey, when properly inoculated, would carry beneficial soil bacteria, including the nodule organisms for the different agricultural and floral legumes; also whether reinforcement and composting of the muck humus would further increase or favor a beneficial flora. (2) further, to determine the simplest method of adding such inoculation. (3) To determine whether one compost may carry the inoculant for all the agricultural and floral legumes at the one time and be sufficiently reinforced and balanced to make a high grade soil inoculator, renovator, stimulant and fertilizer. The work necessitated a study of the flora found in the virgin muck, and the changes brought about by successive years of cultivation, and further, what organisms should be added to make the material a general and beneficial soil inoculant.

Proposed Methods for Investigation

"The methods proposed for carrying out, in the greenhouse, the composting, inoculation of the muck and testing for nodule production were as follows: Four gallon glazed earthen-ware jars were filled with 10,000 grams of muck containing optimum water conditions. After making the composts this amount was found to overfill somewhat the jars, accordingly the amount placed in each jar was 8,000 grams. In making the composts, the muck was used in about the condition it is piled; that is, containing about 65% moisture. All composts were computed on a ton basis. With the exceptions of the composts numbers 9, 11, 10, 12, and 13 to which cyanamid was added and 23 and 24 to which guano was added, no nitrogen was used,

excepting the small amount contained in the soil required for inoculation. Inoculation was carried out by using soil containing a well balanced flora including the nodule organisms of the different groups of valuable agricultural and floral legumes.

"The inoculated soil was added in the proportion of 25 lbs. per ton of muck. A stimulant to increase certain groups of soil flora was added in the form of a crude carbohydrate, at the rate of 30 lbs. per ton, except in composts Nos. 2B, 3B, 4B, 5B, 6B, 7B, and 8B, where 60 lbs. per ton were used.

"In measuring inoculation or the efficiency of the compost for nodule production, four of the most important groups of legumes were grown in each compost,—viz., cow peas—soy beans—alfalfa and crimson clover, and a careful study made of the roots. Further, to study the value of the compost as a general soil inoculator, an inoculation in sterilized sand was carried out, using the compost in different amounts on a two million pound acre basis, viz., two lbs., 100 lbs. and 500 lbs. Five different legumes were employed, each representing an individual group, viz., alfalfa, red clover, winter vetch, cow peas and soy beans. To obtain data on the availability of nitrogen, a growth of rye and millet was used. Some chemical data were taken on nitrates which showed marked variations in the different composts."

Data for Building Composts

"In order to build neutral composts from various alkaline, acid and neutral products such as the commercial phosphates, unleached hard wood ashes, cyanamid, various carbonates, lime, etc., when added to humus, the following experiments were carried out: various quantities of lime were added to the humus from Alphano, New Jersey, to determine amounts required to neutralize the product. It was found that 4.5 to 7 pounds of calcium oxide will completely neutralize a ton on an air dry basis; that one pound of CaO will neutralize five pounds of 14% commercial acid phosphate. It was found that cyanamid is very caustic, equalling lime, and that one pound of cyanamid will neutralize five pounds of commercial 16% acid phosphate. One-tenth pound of CaO will neutralize one ton of sheep manure, and .11 pound of CaO will neutralize a ton of dried blood; one pound of unleached hard wood ashes (chestnut) will neutralize five pounds of commercial 16% acid phosphate. It requires about one pound of

Thomas slag to neutralize one pound of commercial 16% acid phosphate.

"From the above data, some 40 different composts have been made, running to extremes both on the basic and acid sides."

The following mixtures were prepared and composted. After composting one month, crops of rye, millet, and four different legumes, at one time, viz., cow peas, soy beans, alfalfa and crimson clover, were grown on each compost.

A.

Humus	2,000 lbs.

B.

Humus	2,000 lbs.
Carbohydrate	30 lbs.

C.

Humus	2,000 lbs.
Inoc. soil	25 lbs.

D.

Humus	2,000 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 1A.

Humus	2,000 lbs.
Acid Phos. (16%)	50 lbs.
$Ca(OH)_2$	20 lbs.
Organic ash	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 1B.

Humus	2,000 lbs.
Acid Phos. (16%)	50 lbs.
Organic ash	200 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 2A.

Humus	2,000 lbs.
Organic ash	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 2B.

Humus	2000 lbs.
Organic ash	200 lbs.
Carbohydrate	60 lbs.
Inoc. soil	25 lbs.

No. 3A.

Humus	2,000 lbs.
Carb. of potash	50 lbs.
Acid Phosphate	50 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 3B.

Humus	2,000 lbs.
Carb. of potash	100 lbs.
Acid Phosphate	50 lbs.
Carbohydrate	60 lbs.
Inoc. soil	25 lbs.

No. 4A.

Humus	2,000 lbs.
Carb. of potash	15 lbs.

No. 4B.

Humus	2,000 lbs.
Carb. of potash	30 lbs.

Calcium Carbonate	10 lbs.	Calcium Carbonate	20 lbs.
Acid Phosphate	50 lbs.	Acid Phosphate	50 lbs.
Carbohydrate	30 lbs.	Carbohydrate	60 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 5A.		No. 5B.	
Humus	2,000 lbs.	Humus	2,000 lbs.
Potassium Carb.	30 lbs.	Potassium Carb.	60 lbs.
Acid Phosphate	50 lbs.	Acid Phosphate	50 lbs.
Carbohydrate	30 lbs.	Carbohydrate	60 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 6A.		No. 6B.	
Humus	2,000 lbs.	Humus	2,000 lbs.
Sodium Carb.	30 lbs.	Sodium Carb.	60 lbs.
Acid Phosphate	50 lbs.	Acid Phosphate	50 lbs.
Carbohydrate	30 lbs.	Carbohydrate	60 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 7A.		No. 7B.	
Humus	2,000 lbs.	Humus	2,000 lbs.
Thomas slag	200 lbs.	Thomas slag	100 lbs.
Carbohydrate	30 lbs.	Carbohydrate	60 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 8A.		No. 8B.	
Humus	2,000 lbs.	Humus	2,000 lbs.
Thomas slag	50 lbs.	Thomas slag	15 lbs.
Carbohydrate	30 lbs.	Carbohydrate	60 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 9.		No. 10.	
Humus	2,000 lbs.	Humus	2,000 lbs.
Cyanamid	10 lbs.	Cyanamid	25 lbs.
Carbohydrate	30 lbs.	Carbohydrate	30 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 11.		No. 12.	
Humus	2,000 lbs.	Humus	2,000 lbs.
Cyanamid	200 lbs.	Cyanamid	10 lbs.
Acid Phosphate	200 lbs.	Acid Phosphate	50 lbs.
Carbohydrate	30 lbs.	Carbohydrate	30 lbs.
Inoc. soil	25 lbs.	Inoc. soil	25 lbs.

No. 13.

Humus	2,000 lbs.
Cyanamid	20 lbs.
Acid Phosphate	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 14.

Humus	2,000 lbs.
Organic ash	25 lbs.
Sodium Carbonate	15 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 15.

Humus	2,000 lbs.
Organic ash	25 lbs.
Sodium Carbonate	15 lbs.
Carbohydrate	30 lbs.
Acid Phosphate	50 lbs.
Inoc. soil	25 lbs.

No. 16.

Humus	2,000 lbs.
Floats	400 lbs.
Sodium carbonate	15 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 17.

Humus	2,000 lbs.
Floats	400 lbs.
Potassium Carb.	15 lbs.
Carbohydrate	20 lbs.
Inoc. soil	25 lbs.

No. 18.

Humus	2,000 lbs
Floats	100 lbs.
Sodium Carbonate	15 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 19.

Humus	2,000 lbs.
Organic ash	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 20.

Humus	2,000 lbs.
Organic ash	50 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 21.

Humus	2,000 lbs.
Organic ash	25 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 22.

Humus	2,000 lbs.
Organic ash	50 lbs.
Calcium Carbonate	50 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 23.

Humus	2,000 lbs.
Guano	10 lbs.
Calcium Carbonate	50 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 24.

Humus	2,000 lbs.
Guano	10 lbs.
Organic ash	50 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 25.

Humus	2,000 lbs.
Pot. Carbonate	10 lbs.
Acid Phosphate	50 lbs.
Calcium carbonate	100 lbs.
Carbohydrate	30 lbs.
Inoc.	25 lbs.

No. 26.

Humus	2,000 lbs.
Potassium Carb.	10 lbs.
Thomas slag	25 lbs.
Calcium carbonate	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 27.

Humus	2,000 lbs.
Calcium carbonate	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 28.

Humus	2,000 lbs.
Organic ash	25 lbs.
Thomas slag	25 lbs.
Calcium carbonate	100 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

No. 29.

Humus	2,000 lbs.

No. 30.

Humus	2,000 lbs.
Carbohydrate	30 lbs.
Inoc. soil	25 lbs.

Quoting from page 24 of Delaware Bulletin No. 115.

"The Flora in the Different Composts"

"Remarkable changes were brought about in the muck by the application of various ingredients. The different applications of wood ashes, sodium carbonate and potassium carbonate greatly increased the *Azotobacters*, especially the species A. *chroococcum*.

The influence of basic materials in every compost was to reduce molds, but in some cases they increased *Actinomyces*. This observation is in harmony with studies that have been made on agricultural soils, especially those having large amounts of alkaline salts, such as potassium and sodium carbonates. One of the soils from Colorado, high in basic compounds, showed ten million *Actinomyces albus* per gram. This number is far in excess for this organism from soils which are neutral or acid.

The influence of the carbohydrate was to bring up immediately an abundant *Azotobacter* flora, the species varying with the amount and nature of the basic materials applied. As stated above, the basic

materials containing alkaline compounds greatly favored *Azotobacter chroococcum*. The inhibiting action on moulds of a properly balanced compost is seen by comparing cultures A and B, Plate VIII, in which plate A is from a compost that has been properly balanced by alkaline bases (Bul. 115 Del.). The influence of lime and other bases was very marked in the great increase of B. *radicicola*. In some cases the increase was a hundred to a thousand fold or more. The increase in *Azotobacters* was frequently a thousand fold. The rapid disappearance of moulds was remarkable. They evidently died out, as they failed to come up in the culture media when plating. The most remarkable influence of the bases was upon the nitrifiers, here these minute organisms which carry out such an important work, showed a wonderful increase. The importance of these biological processes and the part played by lime and the alkaline compounds must not be underestimated.

"In the composts containing cyanamid and guano, especially the former, marked increases were noticeable in the urea bacteria. The most abundant flora was found in the composts containing cyanamid. Here, a plating from a dilution of 1/100,000 gram of moist compost was not sufficient to permit of proper development. Over 900 colonies of urea bacteria, probably Bact. *fluorescens* per 1/100,000 gram of moist compost were counted or rather estimated in a plate."

In summarizing the results of inoculations, we find the following from pp. 25 and 26:

"The Influence of Various Compounds on Inoculation."

"The influence of the decomposition of the compost is apparently not so active on the soil flora as it is on the host. This was especially to be noted on the growth of the different legumes. In many instances when the roots of the legumes failed to penetrate deeply into the compost because of excessive acidity or alkalinity, the few roots which were to be found showed an abundant inoculation. On the other hand, in certain composts where the nitrogen availability was too great, altho the legumes showed splendid growth and a bountiful root system, little or no inoculation was to be found. It required strong acidity and alkalinity in the compost before a marked falling off in the *B. radicicola* content could be detected in cultures. On the other hand, a slight excess of sodium and potassium carbonates, either from that applied in organic ash or when applied in the form

of chemically pure goods, would show detrimental effect on soy beans and cow peas. However, red clover and more especially alfalfa were quite tolerant to alkali. Alfalfa was in every case the last to die out from excessive alkalinity. The size and apparent health of the nodule was very noticeable on clover and alfalfa grown in some of these sodium and potassium carbonate treated pots. The influence of fertilizers carrying nitrogen, such as cyanamid and guano, was to inhibit or weaken inoculation. This was plainly seen in composts 12, 13, 23 and 24, the two former carrying cyanamid nitrogen, and the two latter, nitrogen from a high grade guano.

Statements have been made that the nodule organisms do not live well in an acid soil. In pot C and pot No. 30, we have added inoculation but no bases; the results were a very good inoculation on all the legumes, soy beans, cow peas, clover and alfalfa and this in a humus that shows a lime requirement of nearly 5,000 pounds of CaO per 2,000,000 pound acre. The growths of the legumes on pots C and 30 were also fairly good, showing that these plants were able to tolerate an acidity in the form of humus, that was nearly three times that of the average acid soil.

The best inoculations were found in those composts which were well balanced in their make-up, such as composts Nos. 8, 25 and 28. Here there is not only an abundant and well distributed inoculation, but also plant growth which shows health and vigor."

"Inoculation in Sterilized Sand By Use of Composts"

"This work was carried out in 7-inch plant pots, sterilizing the sand in the autoclave four hours, at a pressure of fifteen pounds. The composts were used at the rates of 2 pounds, 100 pounds and 500 pounds respectively to a 2,000,000 pound sand acre. (This would be equivalent to about a six inch acre.) Five different legumes were employed, representing as many different nodule organism groups, viz., alfalfa, clover, vetch, cow peas and soy beans. This work was done in duplicate. The sand was treated with ground limestone and washings from wood ashes to supply the necessary minerals. The work was duplicated, using two different composts for inoculation. The appearance of the legumes was somewhat better where 100 pounds and 500 pounds respectively of the composts were used, but upon examination, it was found that good inoculation had taken place in all the pots, and among all the legumes. This work readily indicates that

the organisms for each and all of the important groups of agricultural legumes may be carried in one compost. An observation which was of particular interest in this work was the immense amount of root growth in the sand cultures as compared with the top growth on the legumes. The same relationship must take place in the growth of legumes on weak sandy soils. The following shows dry weights in grams, of tops and roots from the series inoculated with 100 pounds of compost per acre.

Dry Weights of Tops and Roots of Legumes Grown in Sand Cultures.

	Wt. of Tops	Wt. of Roots
Alfalfa	5.1 grams	12 grams
Clover	4.0 grams	12 grams
Vetch	4.5 grams	11 grams
Cow Peas	7.2 grams	10 grams
Soy Beans	6.0 grams	9 grams

The splendid inoculation produced in these sand cultures would indicate that such humus as was used in these experiments, could readily be inoculated and composted so as to carry all the important organisms for the inoculation of the different groups of important agricultural legumes."

TABLE III

"Showing Green and Dry Weights of Rye Grown Eight Weeks"

Compost No.	Green Weight in Grams	Dry Weight in Grams
A Check	63	11
B	88	16.5
C	56	11
D	117	25
1A	252	45
1B	312	45
2A	187	34.5
2B	257	38.5
3A	167	34
3B	78	10.5
4A	95	21.0
4B	220	40

5A	141	31
5B	169	32
6A	160	34
6B	130	23
7A	125	26.5
7B	125	24
8A	Pot removed before data were taken	
8B	173	33.5
9	342	66
10	313	60.5
11	0	0
12	303	47
13	57	18
14	115	19
15	107	25.5
16	127	23
17	89	21
18	146	29
19	210	40
20	149	32
21	146	30
22	152	31
23	383	54
24	281	49
25	Pot removed before data were taken	
26	139	28
27	73	14.5
28	100	22.5
29 Check	50	11.5
30 Check	75	16.5

From Table III, it is very apparent that the addition of certain basis materials has strong influence on the nitrogen assimilation. Check composts A and No. 29 show the response from humus not reinforced or inoculated with soil organisms; these gave a response to rye of 11 and 11.5 grams of dry material.

Check C shows that inoculation alone did not help any, giving a dry weight of only 11 grams; however, when a stimulant or bacterial food such as a crude carbohydrate is added, the pot, without inocu-

lation, is increased by 5.5 grams or 50%, as seen in Check B. When such crude carbohydrate and inoculation are added, the increase is 14 grams or about 122%. Composts numbers 1A, 1B, 2A and 2B show the importance of organic ash, both with and without addition of acid phosphate. The two former have additions of acid phosphate, and show nearly 50% increase above the two latter, which have no additional phosphorus. The difference between Check D, and composts 2A and 2B respectively, shows the influence of organic ash, which is an increase of 9.5 grams and 13.5 grams, or when placed on a per cent basis, is 34% and 54%; the latter shows that when it comes to rye response that 200 pounds of organic ash per ton of humus is superior to 100 pounds. However, 50 pounds of acid phosphate, when added to the 200 pounds of organic ash per ton of compost, show a further increase, viz., the difference between 45 grams and 38.5 grams, or 6.5 grams, which is an increase of nearly 17%.

The detrimental effects of an excess of sodium or potassium carbonates are to be observed in various composts from 3A to 6B and 14 and 18 respectively, in which certain pots made very poor growth, especially 3B, in which 100 pounds of potassium carbonate and 50 pounds of commercial 16% acid phosphate were used. Here, the dry weight was only 10.5 grams, which was 14.5 grams less than check D. Detrimental effects with 15 pounds or more sodium and potassium carbonates were observed unless the compost was properly balanced with acid phosphate. Attempts to supplement applications of ashes with sodium or potassium carbonate resulted in decreased yields of rye, as seen by comparing compost No. 19, containing ashes which gave a dry weight of 40 grams, with composts Nos. 14 to 18 respectively, in which ashes were reinforced with sodium or potassium carbonates; here, the weights were 19, 25.5, 23, 21 and 29 grams respectively.

Calcium carbonate does not equal the response of wood ashes; this is seen by comparing compost No. 19, containing 100 pounds of ashes per ton of humus and producing a dry weight of rye of 40 grams, with compost No. 27 containing an equal amount of calcium carbonate per ton of humus, which gave a rye response of only 14.5 grams."

"Crop Response from Millet"

"A study of the crop response from millet shows even more favorable results from the composts. None of the pots reinforced

with cyanamid nitrogen or gauano equalled the composts Nos. 1A, 1B, 7B and 22. In fact there were 12 different composts which gave higher crop production than did those reinforced with cyanamid and guano.

With the exception of compost No. 22, compost 1B was again the most productive, being closely followed by No. 7B and No. 1A. The dry weight with millet from these leading pots was over five times that from check A, while with rye it was only four times that of the check. No attempt will be made to interpret the response from the different composts. It is sufficient to indicate the compounds which appear to be very active in bringing about such response. Carbohydrates, apparently have great influence as there is a difference between raw humus in check A and that of humus and the crude carbohydrate in check B of 38 grams which is a response of nearly 176%. The addition of ashes to check D, as seen in pot 2A, gives 94 grams dry weight or an increase from 65 to 94 grams, that is 29 grams, which is equal to 44.6% increase.

If compost 1B is compared with check A, it is evident that the addition of acid phosphate, ashes, the crude carbohydrate and inoculation changes the response from 22 grams, dry weight, to 116 grams or an increase of 472.7%."

Summary

1. "Muck humus of the quality used in these experiments becomes, when properly balanced and reinforced, a very favorable medium for carrying a beneficial soil flora.

2. The flora of virgin muck humus was found low in many of the beneficial bacteria. Different legume nodule organisms were absent, though the clover group was present to a limited amount. The alfalfa, vetch-pea, bean, cow pea and soy bean groups were absent.

3. Muck humus when properly reinforced, inoculated and composted will carry the several groups of the different legume organisms in one and the same compost, producing a strong inoculation on the different legumes.

4. Inoculation of the compost may be satisfactorily brought about by using soil which has been proved to give strong inoculation to each of the groups of legumes. *Azotobacter chroococcum* may be readily introduced by using western soil; soils from Colorado and North Dakota were used in these experiments. Other species of

Azotobacter were common in eastern soils. Nitrifiers are common in all good soils.

5. Muck humus properly reinforced, inoculated and composted gave strong inoculation to five groups of legumes, when the latter were grown in sterilized sand cultures, using the compost at the rate of two pounds per a 2,000,000 pound acre. A somewhat stronger inoculation and growth were produced by using the compost at the rate of 100 and 500 pounds respectively to a two million pound acre in sand cultures.

6. Crude carbohydrates and basic compounds such as organic ash and Thomas slag proved very efficient in bringing up an active legume flora, and likewise a strong nitrogen fixing and nitrifying flora.

7. Organic ash proved the most active mineral application for use in the compost as indicated by crop response.

8. By properly reinforcing the composts with certain basic compounds, all the nitrogen required for crop response was made available as indicated by the growth of millet; the crop response from additional nitrogen from cyanamid and guano did not equal that from certain of the composts.

9. This work shows that the nodule organism may live well in a muck humus having a lime requirement of 5,000 pounds of CaO to a two million pound acre; also that in this same acidity four different legumes, viz., alfalfa, red clover, soy bean and cow pea, made good growth and took good inoculation without addition of any bases.

10. Muck humus as herewith reinforced and composed gave splendid crop response to rye and millet without the addition of nitrogen, indicating it to be a product of good fertilizing value."

BACTERIZED PEAT AS A FERTILIZING MEDIUM [1]

By Dr. G. H. Earp Thomas

It gives me great pleasure to address you today on a subject to which I have given many years of careful study, namely, the bacterization of peat as a fertilizing medium.

Twenty years of commercial distribution of agricultural bacterial products has given me a vision of the needs of the practical farmer. I feel confident that bacterial organic fertilizers are destined to play a prominent part in the growing of plants in the near future. In other words, the organic fertilizer period is here. The farmer's anxiety for hasty production of crops, the lack of manure and the stimulating nature of most fertilizers has naturally brought about an imbalance in the soil. The organic matter has in general been depleted or worn out, and the crops suffer in consequence. The lack of balance in plant nutrients robs the plant of its insect and disease protecting substances, and it readily falls prey to the ravaging hordes of plant destroyers. I believe this to be true from several closely checked up experiments, some of which may be illuminating.

In 1915 some chemical fertilizer put up in coated granules was inoculated with mixed cultures of bacteria, and half a row was planted to beans with same kind of fertilizer without inoculation, and the remainder of the row was planted with the inoculated fertilizer. When the plants had matured, almost all the beans on the treated portion were fairly well developed and normal, and to our astonishment at the time the untreated beans were curled and anthracnozed so badly as to be of very little value.

Another example occurred in our gardens at my home in New Zealand. Two plum trees of the same variety, same age and on the same type of soil, were infested each year in early spring with a minute slug, and they destroyed all the leaves. The slugs would depart and new leaves develop, but little fruit appeared. My brother, remembering the bean experiment, made a fairly heavy application of organic fertilizer to one of the trees. It opened its leaves in spring a little earlier than its mate, and went right through the season without

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[1] Delivered at the 17th Annual Convention of the American Peat Society, December 7th, 1923, at Washington, D. C.

slug infestation, while the mate as was usual lost its leaves and later bore a new lot. The fruit on the treated tree was all perfect and very plentiful, and proved our supposition.

With alfalfa, a mixed inoculation of sulphur bacteria and nitrogen fixers shows freedom from root rot and white fly. Likewise, cotton in one test showed no boll weevil, I think in this case due to early maturity. The weevils devoured most of the other cotton. I was particularly impressed with a result we had at Sheepshead Bay, New York, on a sandy waste reclaimed from the ocean bed. A breastworks was built in the ocean front and the sand hydraulically pumped over the land. It blew away badly and caused serious losses, and we were consulted with the object of planting it to stop the sand drifting. We accepted the contract in 1912 about April, and used organic fertilizer, and after many hardships due to wind and sand shifting, seeded the stretch of sand. It was a complete success, and our guarantee to stop the sand moving was sustained, and even today there may be seen almost a perfect stand of the crops we then planted. Some time later, the owners of the land made another planting themselves close to where we had finished, and the plants damped off with mildews, and never made a good stand, all tending to show a lack of balance. The sand on the treated portions today is a sandy loam; the sand adjoining it is as it was in 1912.

I could give other illustrations of my point, but they are unnecessary. It is quite evident to me that organic matter, as well as bacteria, play an important part in soil fertility.

Recently I prepared some thermic types of bacteria for the destruction of garbage. A battery of cells was prepared for the destruction of garbage by bacterial action. The cells were built in Patterson, New Jersey, by New York engineers headed by the City Engineer of New York. The garbage was placed in the cells in winter, wet and frozen; the bacteria were added, and the whole mass of garbage was reduced to humus in a few weeks, reclaiming the valuable plant foods, and producing a valuable organic tankage for plant production when properly balanced.

For several years, operators have been distributing bacterial organic fertilizers made under my processes. The results have been most disappointing to me, as they have been so variable; at one time good, at another time, bad. Sometimes, I feel like laughing and sometimes I feel like crying. Fortunately, I have not felt personally re-

sponsible for the discrepancies, as I have not been closely identified with the companies turning out the products for any length of time, but they have had my formulas. It needs more than formulas to turn out a good product all the time, particularly such a sensitive thing as a bacterized peat product. Bacteria are sensitive things, and must have a favorable nidus for growth, or they strike, and as they can not be readily observed when striking, great pains must be made to make them satisfied. It can be done, as many of the reports will show. It is mostly a question of proper factory management to carefully check up each step in the production of the material, regulating the reactions of the batches to insure a high count of desired plant food producing micro-organisms. This accomplished, it is then necessary to pass the criticism of the all too ready scientists to tread the thorny road of commercial sales. As I have introduced new products, starting with Farmogerm, I have always had to pass the barrage of savage criticism of co-workers. Farmogerm is sold widely and has proven successful. Several other articles have likewise weathered the storm, and I hope that my organic fertilizer will soon pass the breakers if it is a worthy article; if not, I hope to do the wrecking myself. However, I believe that organic fertilizer prepared with appropriate bacteria will go a long way towards re-establishing the balance to the soil which is gradually but surely dwindling and make more wealth to the agriculturist than has hitherto been possible. Bacteria are essentially protoplasmic, rich in protein and the right kind carry a perfect balance of plant nutrition; they grow in vast numbers through a favorable soil; are economical and lasting; and give a better balanced crop of superior feeding quality. This I know to be true, as I have made numerous feeding tests with animals. I am now preparing very delicate blood foods for metabolic disturbances which are used by physicians for subcutaneous hypodermic injections. All this material is secured from healthy plants grown from well balanced bacterized soil. Not only does the well balanced soil produce healthy plants, but tends also to do likewise to man or animals.

I wish to close by drawing attention to the grossly exaggerated claims made for organic materials. They have as good a place as manure in agriculture, but they will not supplant chemical fertilizers which also have a definite position. As an amendment to soil treatment they will aid the farmer in producing more from lime, or fertilizers, and when used on favorable soils, will well repay the users.

PEAT IN THE NETHERLANDS

By Arthur H. Redfield [1]

Formerly U. S. Trade Commissioner at The Hague

"Waar is het gelukkig land
"Waar het volk ons' moeder brand?"

runs an old Dutch proverb. "Where is the happy land where the people burn our mother?" The answer to the riddle is of course the Netherlands where for many centuries the people have been burning their Mother Earth in the form of peat. Relics found by archaeologists indicate that the Romans cut peat in the Low Countries in the first three centuries of our era.

During the Middle Ages peat was the familiar household fuel of the Netherlands. In the middle of the 13th century an elaborate code of regulations governing peat-cutting existed in the Province of Groningen. From medieval times down to the present, peat has been the Dutch fuel *par excellence* for both household and industrial purposes. It fills an important place in the economy of a densely populated commercial and industrial country poorly provided with coal and destitute of mineral oil and natural gas.

Physiography of the Peat Lands

Nearly three-fifths of the area of the Netherlands consists of lowland, less than 100 meters (300 feet) above sea-level, formed chiefly during the recent epoch and made habitable only through man's efforts. This lowland is a flat alluvial plain, separated from the sea by chains of sand dunes (some of which attain a height of 60 meters), and broken by wide estuaries and tidal channels. It is believed to represent an ancient lagoon closed by a sand barrier and filled by both river and tidal sediments. Layers of peat alternating with the silt layers indicate that littoral conditions prevailed during a time of relative depression of the land (fully 20 meters since the end of the Pleistocene). The greater part of this lowland is below the level of the

[2]Published by permission of the Director, U. S. Geological Survey.

sea, in places as much as 5 or 6 meters. These depressions are occupied by peat bogs of the so-called "low fen" (laagveen). Drained, denuded of their peat, and intensively cultivated, these former swamps and lakes constitute the well-known Dutch "polderland."

Although the lowland is essentially a flat plain, it shows nevertheless certain differences in altitude. The lowest parts are the bottoms of the ancient lakes, where the peat layer has been wholly destroyed by the waves or has been removed by man for fuel. The surface is 4 to 6 meters below sea-level and here the older estuarine clay is exposed. These former lakes are surrounded and separated by areas where the peat bed is still preserved and where the surface of the ground is now only one or two meters below sea-level in consequence of renewed subsidence and the shrinking of the dried soil. The recency of the subsidence is shown by the occurrence of numerous trunks of trees standing vertically in the peat, with their roots still embedded in the underclay. Where, however, the area was formerly exposed to the invasion of the sea after the deposition of the peat, the peat has been more or less removed and replaced or overlain by a new estuarine clay. The later in age the deposit of estuarine clay, the closer it lies to sea-level. Conversely the older peat bogs in Friesland, Groningen, and Zeeland lie farther below sea-level than the younger ones.

In contrast to the western lowlands and the coast is the older and higher delta land of the south and east. This higher land is built up of Pleistocene deposits, chiefly sand. It comprises the remainder of the Netherlands with the exception of the plateau of southern Limburg. The surface nowhere exceeds 100 meters (330 feet) in altitude, except in a few mounds on glacial ridges in Gelderland. The delta land may be subdivided into a glaciated northern portion in Gelderland, Overyssel, Utrecht, and Drenthe, an unglaciated southern portion in North Brabant and northern Limburg, and the wide valleys of the Maas, the Rhine, and the Yssel.

Since the close of the Pleistocene, many stream valleys have been excavated in the soft Pleistocene sand. Some of these have been invaded by the sea and covered with marine clay; others have been covered with fluviatile clay; and in others a state of insufficient drainage has favored the formation of peat bogs of the so-called "high fen." The high fens of western North Brabant occupy former beds of the Scheldt; those of eastern North Brabant (the Peel district)

occupy former beds of the Maas; and those of Overyssel and Drenthe occupy the abandoned channels of former fluvioglacial streams.

Extent of Deposits

Peat is won in the Netherlands in both the high fens (hoogvenen) and the low fens (laagvenen). High fens are those which stand on solid ground, where the ground-water table reaches nearly to the surface of the earth; and low fens are those which occur in shallow water at depths not exceeding one meter (3.28 feet).

The low fen is formed in shallow pools from water plants which after death accumulate under water, and do not completely decay, but form a vegetable muck. Low fens occur in the center of Groningen; in the southwest, south, and center of Friesland; in the west of Overyssel; in a strip through Drenthe extending to the east of the Hondsrug; in the northwest of Overyssel; in North Holland south of The River Y; and in South Holland scattered over nearly the whole of the provinces behind the coastal sand-dunes, except for the clay-stretches along the Old Rhine and for the reclaimed bottoms of former lakes. In the west of Utrecht also is a strip of low fen, and in the southern part of North Brabant and the northern part of Limburg is a strip of low fen known as "the Peel."

Low fens formerly occurred in nearly all the low-lying parts of the Netherlands, where stagnant or almost stagnant water lay, especially in a great continuous zone in the extensive site of a former bay. For centuries the Netherlanders have dug peat from the low fens, so that numerous lakes, now partly drained, occur.

Half a century ago, the low fen comprised an area of 336,064 hectares or 11.1 per cent of the area of the Netherlands. No data exist regarding its present extent. It forms beds of ½ meter to 4 meters (1.64 to 13.12 feet) thick. In certain places, notably in Friesland, Drenthe, and near Halfweg and Nieuwer-Amstel in North Holland, it is worked for peat. When the peat is cut off the land water gathers in the hollows remaining. Many of these ponds have been drained and the bottom used for pasture or gardening.

High fens occur on flat areas or in shallow basins on the sand belts, where the plants do not wholly decay because of the moisture, but are turned to peat. Heather, rushes, wool-grass, and sphagnum-moss are the chief plants which form high fens. The high fen is

formed above the normal water level, and the peat has a fibrous structure. The high fen lies upon the high but poorly-drained ground.

In the middle of the 19th century the high fens covered 91,499 hectares. They now cover about 31,319 hectares. Their area has been decreased to such an extent by the digging off of the peat that now no extensive bogs occur in the high fen districts.

Since 1900 the use of sphagnum-peat as stable litter has hastened the exhaustion of the high fens. The largest areas of unworked high fen today comprise, in Drenthe, 19,569 hectares; in Overyssel, 5,703 hectares; in Groningen, 2,797 hectares; in North Brabant, 1,706 hectares; and in northern Limburg adjoining North Brabant, 1084 hectares. Peat is still cut extensively from the high fen in Drenthe, in Overyssel, and in the Peel district of southern North Brabant and northern Limburg.

Area of peat bogs worked in the Netherlands in 1915

	Hectares
Friesland	1,283.08
Drenthe	12,195.92
Groningen	898.10
Overyssel	2,718.42
North Holland	239.73
Utrecht	345.48
South Holland	54.36
Gelderland	3.50
North Brabant	2,780.00
Limburg	550.00
Total in Netherlands	21,078.59

Production, Imports, and Consumption

Nystrom in 1908 estimated the annual peat production of the Netherlands at more than 1,000,000 tons. According to such official statistics as are available, the production of peat in the Netherlands amounted in 1900 to 2,410 million "bricks"; in 1910 to 1,824 million "bricks"; and in 1915 to 1,765 million "bricks." The equivalents in terms of weight are difficult to determine, as the two varieties of peat are cut into "bricks" of two different sizes, and as air-dried peat

varies considerably in specific gravity. The Dutch production of peat may be estimated, however, at 683,000 tons in 1900; 517,000 tons in 1910, and 500,000 tons in 1915.

The following table gives a statement of peat production in 1915, according to data obtained from questionnaires sent out by the Labor Inspection in October, 1916. Returns were received from 979 producers; from 333 smaller producers no information was received. The figures given represent accordingly minimum rather than maximum production.

PEAT PRODUCED IN THE NETHERLANDS, 1915, BY PROVINCES

In thousands of pieces

Provinces	For domestic fuel	For factory fuel	Total
Friesland	120,660	480	121,141
Drenthe	774,188	398,039	1,172,227
Groningen	44,279	30,499	74,778
Overyssel	127,018	12,199	139,217
North Holland	79,009	------	72,009
Utrecht	80,676	1,130	82,002
South Holland	9,004	------	9,004
Gelderland	711	------	711
North Brabant	45,994	21,731	67,725
Limburg	19,252	------	19,252
Netherlands	1,300,788	464,278	1,765,066

The National Fuel Administration (Rijkskolenvoorziening) in 1919 estimated domestic deliveries of peat during the year ended March 31, 1917, as equivalent in fuel value to 400,000 tons of bituminous coal; deliveries during the year ended March 31, 1918, as equivalent to 450,000 tons of coal; and deliveries during the year ended March 31, 1919, as equivalent to 650,000 tons of coal. Assuming that peat has an average calorific value of 9,000 B. t. u. per lb., or about 3/5 the heating value of bituminous coal, deliveries of peat may be estimated at 667,000 metric tons during the year ended March 31, 1917; 750,000 tons during the year ended March 31, 1918; and 1,082,000 tons during the year ended March 31, 1919.

The very nature of the industry makes it difficult to obtain com-

plete statistics. The cutting of peat is carried on, not as in most mining industries by a few large, well-organized companies, but by hundreds of individual farmers as well, who dig peat out of their own land for their own and their neighbors' use.

Peat production in the Netherlands varies greatly from year to year, according to market conditions. Usually it is cut from the fens in the central, eastern and northeastern provinces, and shipped to the cities by boat. Most of the trade consists of the purchase of a boat-load of peat by the "skipper" of a canal boat, who sells it in the city at whatever price will repay him his freight and expenses plus a small profit.

The peat dug in the Netherlands is sold chiefly within the country. Some peat is even imported from neighboring parts of Germany to fill the demand. The following table shows to what extent the Netherlands depends on imported peat.

IMPORTS, EXPORTS, AND NET IMPORTS OF PEAT IN THE NETHERLANDS

1910-1922, in metric tons

Year	Imports	Exports	Net Imports
1910	42,287	9,850	32,437
1911	41,134	9,768	31,366
1912	65,280	11,026	54,254
1913	89,242	10,960	78,282
1914	58,825	17,800	41,025
1915	31,255	4,531	26,724
1916	28,981	85	28,896
1917	29,534	35	29,499
1918	22,854	----	22,854
1919	12,297	4,481	7,816
1920	7,442	70,056	62,614
1921	48,465	1,617	46,848
1922	43,416	430	42,986

Both the production and the consumption of peat in the Netherlands were formerly large but have diminished considerably through the increasing use of coal both for household and for industrial fuel. Nevertheless in the fen districts much peat is still burned both in factories and in dwellings.

In the strawboard and potato-flour factories of Groningen peat has always been a recognized fuel. During the World War the exploitation of the peat bogs for fuel increased considerably on account of the scarcity of coal and irregularity of coal deliveries. Factories of all kinds were compelled to turn to the lower grades of fuel. Even in the old peat diggings of Holland, which after the peat is exhausted are being prepared for draining, peat is now being dug. It was proposed in 1919 to erect in Drenthe, the present center of peat-cutting, a central power plant burning peat, to supply the surrounding towns with electricity.

Uses of Peat

In the high fens the so-called "long peat" is cut in bricks of about 42 x 15 x 15 centimeters (16.5 x 5.9 x 5.9 inches). It is brown, fibrous, relatively coarse in texture, and burns relatively freely, falling apart as it burns. "Long peat" is consumed chiefly by brick-kilns, paper, strawboard, and potato-flour factories. The lighter sorts of long peat are shipped in considerable quantities to the cities to be burned as domestic fuel. Much peat, chiefly from the high fens, is made into peat litter or peat moss. This branch of the industry deserves more extended treatment.

In the low fens the "short peat," is cut, in bricks of about 28 x 15 x 15 centimeters (11.02 x 5.9 x 5.9 inches). The "short peat" is black in color, and less fibrous in texture than the "long peat." It serves for the most part as household fuel. It is slow-burning, and well suited for the air-tight stoves by which the majority of Dutch dwellings are heated. At bedtime, the glowing brick of peat can be lifted out of the stove with tongs, placed in a vessel called a "domper," partly buried in ashes, and enclosed under a close-fitting lid. In the morning, the peat brick still smoldering, can be returned to the stove, and fanned to a glow by open drafts. Many elderly ladies carry to church and into unheated rooms little earthenware footwarmers in which the heat is supplied by a piece of burning peat.

Manufacture of Peat Litter

The upper layer of a peat deposit, known in the Netherlands as "bolster," is usually the least suited for industrial fuel. It is looser, more porous, and lighter in color than the lower layers. This upper layer was formerly either thrown aside as useless, or was sold for a

small sum to the neighboring farmers for fertilizer. This use of "bolster" peat is still followed in places on a small scale. About 30 years ago, however, the "bolster" began to be utilized for the manufacture of peat litter, and its value has increased correspondingly.

According to Dutch law, one-half of the outer peat crust (known as "bonk aarde") must be set aside for later use in the cultivation of the stripped areas. The "bolster" occurs immediately below this outer crust in a layer, which in many places, exceeds a yard in thickness.

The "bolster" is cut between September and February, if the weather is favorable and free from snow or frost. The peat is taken out in long strips measuring 42 by 15 x 15 centimeters and weighing about 7 kilograms (15.4 lbs.). About 14,000 of these strips make up 100 cubic meters of rough peat, from which 100 bales of peat litter weighing 100 kilograms (220 lbs.) each are produced. One hectare (2.47 acres) of peat land covered with "bolster" to an average depth of one meter (3.28 feet) yields accordingly 10,000 cubic meters or 10 metric tons of peat litter.

After cutting, the peat is stacked for drying in the open air. If the season is good, the material is sufficiently dried by August or September to be taken to the factory. The peat is carried on specially built barges along the numerous canals which intersect the peat-fens for drainage and for highways.

In order to save freight costs, the factories are situated as closely as possible to the peat lands. The process of manufacture is simple, consisting chiefly of breaking the peat by machinery and then baling it in a compressor. The finished peat litter is smaller in bulk than the raw material, and therefore easier and cheaper to transport.

The finer peat litter is largely used for packing trees and plants in nurseries and gardens. It is utilized as a base in the preparation of molasses fodder for cattle. The molasses used is a by-product of the sugar factories.

The coarse variety is considered well adapted for use in stables as a base for manure, on account of the readiness with which it absorbs moisture. It is both clean and cheap. An average of 50 kilograms (110 lbs.) a year is required for each horse.

In 1918 there were in the Netherlands 16 firms or organizations controlling 20 peat litter factories. Several of these are owned cooperatively by the peat cutters themselves. Of these factories one is situated in the Province of Groningen; nine on the peat moors of

Drenthe; eight in Overyssel, and two in the Peel district of North Brabant. In North Brabant the supply of "bolster" peat is nearly exhausted, so that one of the firms owning a factory in the Peel has also established a plant in Drenthe.

The consumption of peat litter has increased greatly in recent years, especially for horticultural purposes. Mixed with molasses, it makes an excellent feed for livestock. Only a small part of the output of peat litter is sold within the Netherlands; the greater part is exported.

PRODUCTION, DOMESTIC CONSUMPTION, AND EXPORTS OF PEAT-LITTER IN THE NETHERLANDS, 1911-1917, IN METRIC TONS

	Sold in the Netherlands	Sold in foreign countries	Total production
1911	40,490	182,028	222,518
1912	48,370	194,582	242,952
1913	47,712	181,921	229,633
1914	47,070	130,227	177,297
1915	54,227	219,163	273,390
1916	62,937	157,748	220,685
1917	105,657	126,891	232,548

Formerly certain factories increased the weight of their peat litter at the expense of its quality by using too high a percentage of water, thereby destroying the hygroscopic properties which constitute one of the chief advantages of the material. An agreement on the part of the manufacturers now provides for an inspection and analysis of the peat litter at irregular intervals, and for a fine of 3 guilders ($1.21) a ton for every per cent of water above 40 per cent contained in the litter.

OTHER MANUFACTURES OF PEAT

Peat fiber from "long peat" and peat briquettes from "short peat" are also manufactured on a small scale in the Netherlands. No statistics of the output of these products are available. The following table, from Dutch official statistics of foreign trade, shows the net imports of peat-litter, peat fiber, and peat briquettes, obtained by balancing exports and imports of each commodity:

NET EXPORTS OF PEAT PRODUCTS FROM THE NETHERLANDS, 1910-1922, IN METRIC TONS

Year	Peat litter	Peat fiber	Peat briquettes	Total
1910	186,310	b	b	186,310
1911	181,698	b	b	181,698
1912	180,691	b	b	180,691
1913	162,767	b	b	162,767
1914	126,380	b	b	126,380
1915	213,569	b	b	213,569
1916	178,610	b	b	178,610
1917	126,990	30	186	127,206
1918	196,027	30	--	196,057
1919	29,185	684	–174	29,695
1920	46,974	264	3,080	50,318
1921	25,645	–93	10	25,562
1922	44,194	10	--	44,184

a Statistiek van den In-, Uit-, en Doorvoer, Koninkrijk der Nederlanden.

b Not separately stated.

USES OF CUT-OVER LANDS

The soil of the areas in which the high fen has been entirely removed is known as "dalgrond." This land when drained and enriched by waste peat and artificial fertilizer has proved very fruitful. The many lakes and the low altitude facilitate the digging of canals, and give easy transportation by water. This has brought new population into districts formerly considered barren.

In earlier times a little buckwheat was grown on the high fen, which was cleared by burning off the peat. For the most part, however, they lay uncultivated, overgrown by heather and briar, sodden by water, and forming impassable bogs. Today on the bottoms of the cut-over high fens, where a part of the spongy peat (*bonk aarde*), less valuable for fuel, is left to form loam, stand flourishing agricultural settlements, known as "fen colonies" (veenkoloniën). These are numerous in the south of Groningen and the east of Drenthe; in southeastern Friesland and western Drenthe; around Hoogeveen in southern Drenthe; along the Dedemsvaart and the Almeloo-Coevorden

Canal in Overyssel; in the Veenendaal or "Fen Valley" of Gelderland; and the Peel district of North Brabant and northern Limburg. In contrast with the typical Dutch agriculture of the more southerly and westerly provinces, little livestock is raised in the fen-colonies. They are devoted almost entirely to the raising of potatoes, oats, and rye for sale or manufacture. Much artificial fertilizer is consumed on these cut-over peat lands.

In 1917 about 32,000 hectares (80,000 acres) chiefly of former peat land in the Provinces of Drenthe, Friesland, and Overyssel were sown to so-called "industrial" potatoes. These when harvested were shipped to 35 potato-flour factories, of which 20 were owned cooperatively by the growers and 15 by private capital. These factories consumed 486,000 metric tons of potatoes in 1909; 816,000 tons in 1912; and 774,000 tons in 1915. They produced 85,000 metric tons of potato-flour in 1909; 140,000 tons in 1912; and 135,000 tons in 1915.

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SCOPE AND PURPOSE OF SOCIETY

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. It is an organization devoted to research and to the dissemination of information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat and muck.

Through its Advisory and Research Committee, consisting of botanists, geologists, chemists, bacteriologists, and engineers, the society will answer inquiries from members relating to the use of their deposits. There is no charge for general service.

NATURE AND USES OF PEAT AND MUCK

Peat and muck are residues resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas covered or saturated with water. They may be identified as the dark-colored soils found in bogs and swamps and in other low places. The commercial uses of peat and muck are varied. In the United States they are utilized chiefly as crop soils, as soil conditioners, and as ingredients of fertilizers. In some of the countries of Europe peat is used for fuel and is the basis for small manufacturing industries. Gas, charcoal, coke, and some by-products are produced in small quantities. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of litter, packing material and rugs, and selected varieties of peat moss have been used to make surgical dressings.

ECONOMIC ASPECTS OF PEAT

The United States contains over 12,000 square miles of undrained peat and muck land. The average deposit, if used for industrial purposes, will yield 200 tons per acre-foot. It is estimated that the deposits would be capable of yielding about 14 billion short tons of air-dried peat. Peat and muck areas are distributed throughout the Great Lake, Pacific Coast, and Atlantic Coast States. Peat and muck in Canada cover 37,000 square miles. According to published statistics, European countries annually consume about 50 million tons of peat fuel.

MEMBERSHIP

Present membership of the American Peat Society consists largely of agriculturists, engineers, and peat and muck land owners and producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetable matter, and in the production of fuel or generation of power, may join. Applications should be addressed to the secretary. Membership and subscription to the Journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS

Meetings of the Society are held annually in important cities throughout the peat regions. Papers are presented relating to the subjects enumerated. A quarterly journal, containing the proceedings of the Society, papers concerning all phases of peat, muck, and allied subjects and news of the industry, is published and sent to members. The scope of the papers is very broad, including the location of deposits, drainage and reclamation problems, methods of cultivation, fertilizer requirements, crop adaptation, cultural practice, physical and chemical characteristics, engineering practice, and production methods. One of the principal objects of the Society is the exposition of extravagant claims made by promoters.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society.

(Date)

Mr. Charles Knap, *Secretary-Treasurer,*
American Peat Society,
2 Rector St.,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This action is prompted by my interest in the science and utilization of peat and muck and the welfare of the society.

Yours very truly,

(Signature)

(Address)

CONTENTS

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Dr. Joseph Hyde Pratt,
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Chapel Hill, N. C.

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Myron W. Robinson
New York, N. Y.

Frederick V. Coville
U. S. Department of Agriculture
Washington, D. C.

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PROCEEDINGS OF THE EIGHTEENTH ANNUAL CONVENTION

The Eighteenth Annual Convention of the American Peat Society, held in Minnesota in the fall of 1924, was a constructive and interesting meeting. Those who attended the sessions and visited the muck and peat farms of Minnesota are no longer doubtful of the value of these types of soils for agricultural purposes. On the other hand, the feeling was that as a source of fuel the value of peat was remote. Many of the sessions were attended by more than one hundred persons. Mr. F. J. Alway arranged the program.

The delegates assembled at Albert Lea on September 23 and were taken from that city to Hollandale in cars furnished by Mr. G. H. Payne, organizer of the Hollandale Muck District. During the morning they inspected the 6,000 acres of muck land in crop. Yields of potatoes, onions and other crops were good. An excellent luncheon was served by Mr. Payne and his associates at the Hollandale school.

The first session was held immediately following the luncheon. Mr. J. H. Beattie, President of the Society, was in the Chair.

Mr. Payne related the history of the Hollandale reclamation project, and Mr. Paul N. Davis spoke on experiences with truck crops on muck soils.

On the second day the convention met in the morning at the Mines Experiment Station, University of Minnesota, and after a paper on "Producer Gas from Peat" and a demonstration, Prof. Henry Hindshaw of Minneapolis spoke on "Experiences in Peat Fuel Production," Mr. G. B. V. Elliott on "The Drainage of Peat Soils" and Colonel

John T. Stewart on "Relation of Water Table to Flow Line of Drains."

In the afternoon the members of the Society visited the Coon Creek Peat Experimental Fields of the Minnesota Agricultural Experiment Station and later drove through the peat farming lands of Anoka County where clover and timothy hay and potatoes are the chief crops being raised. A severe frost on August 13 had injured the potatoes on many of the fields of peat, although no damage had been done on the fer-

Inspection of Onion Crop Grown on Muck Land
at Hollandale, Minnesota

tilized plots at Coon Creek. All the Anoka fields visited, as well as the experimental field, are of the high-line type and both potash and phosphate are necessary in order to secure profitable yields. At Coon Creek potatoes were dug on many of the plots and excellent yields were shown. Sugar beets and various other root crops were good and the hay crop had been very heavy. The corn had made a poor growth and was said to be very inferior to that in any of the preceding five years. One of the most interesting exhibits was the excellent pasture of blue grass and white clover that had been in use since the beginning of the summer. The Minnesota Experiment Station recommends that the peat

soils of that State be largely devoted to the production of tame hay and improved pasturage.

That evening at the Agricultural Experiment Station a meeting was held at which there were papers by Dr. Fred Krantz on his experiences with vegetable crops on peat. Dr. Paul M. Harmer of the Michigan Agricultural Experiment Station spoke on fertilizer combinations on Michigan muck soils and Prof. G. H. Nesom on potato production on Minnesota peats.

During this session the annual business of the Society was transacted, at which officers were elected for the ensuing year. Mr. J. H. Beattie of the U. S. Department of Agriculture was elected President, Mr. W. C. Steenburg of South Bend, Indiana, First Vice-President, Mr. Paul M. Harmer of the Michigan Agricultural College, Second Vice-President, and Mr. F. J. Alway of the University of Minnesota was elected to succeed Ernest V. Moore on the Executive Committee. No other changes were made. C. C. Osborn, editor of the Society, presented the financial statement of the Secretary-Treasurer. The statement appears in detail at the end of this discussion.

A discussion was had of the financial problems of the Society, during which Mr. Osborn stated that Mr. J. N. Hoff had agreed to contribute $200 and that he would contribute a like sum. Since the Convention was held a contribution of $200 has also been received from Mr. W. C. Steenburg.

The next morning a small party drove northward, visiting the two experimental fields of the Universiay of Minnesota near Milaca. At the first, which had never been fertilized and had been only recently brought under cultivation, potash alone sufficed to cause an excellent growth. At the second, which is a typically low-lime bog, all crops failed unless the land had first been limed. In addition it needed potash and phosphate for all crops, and for potatoes nitrogen in addition.

Then the party proceeded to the Grand Rapids Experiment Station where Prof. Bergh demonstrated the use of peat as litter. He has been using this for some years past at the large dairy barns on the Grand Rapids Experimental farm. The party spent the night at Grand Rapids and the next morning drove to Fens where the Experiment Station has maintained an experimental field since 1917. The peat in this district is of almost exclusively the high-lime type and when first brought under cultivation needs phosphate only, but later both potash and phosphate. A large number of settlers are there en-

gaged in the growing of truck crops for which the cold season had been exceptionally unfavorable. At Fens the party was met by Mr. Wallace Ashby of the Duluth and Iron Range Railway, who then guided them to Meadowlands where he entertained them at dinner and showed them over the extensive trucking area around Meadowlands. There the peat is practically all of the low-lime type, but where it had been well limed and treated with potash and phosphate and nitrate, excellent lettuce, celery and cauliflower were being raised. From Meadowlands the visitors drove to Duluth to take the train home or return southward by automobile.

Summary of Cash Receipts and Disbursements
for the Year ending June 30, 1924.

RECEIPTS

Cash on Deposit July 1, 1923 per last report		$ 51.00
Cash Received from Subscriptions		525.62
Journals Sold		24.55
Advertisements		45.50
Donations:		
Arnold, L. B.	$200.00	
Jas. H. Baldwin, Pres. Crex Carpet Co.	200.00	
Hoff, J. N.	200.00	
Osborn, C. C.	200.00	
Steenberg, W. C.	200.00	$1,000.00
Cash Advances		270.80
		$1,917.47

DISBURSEMENTS

Editing & Publishing Journals	$1,278.28
Expenses of Annual Meeting 1923	387.98
Press Clippings	60.00
Stationery	30.40
Postage	4.80
Typewriting	5.00
Storage of Back-Numbers of Journal	13.80
Bank Exchange	.10
Partial payment of Cash advances	104.50
Balance of Cash on Deposit June 30, 1924	32.61
	$1,917.47

STATEMENT

ASSETS

Unpaid subscriptions due from Members	$155.00
Back-numbers sold, unpaid	10.00
Cash on Deposit, as above	32.61
Deficit	137.02
	$334.63

LIABILITIES

Acceptances, with interest, due Nov. 5, 1924 to repay balance Cash Advances	$176.63
Advances made by Editor for printing Journal	158.00
	$334.63

THE AGRICULTURAL USE OF ACID PEATS [1]

By Frederick V. Coville

U. S. Bureau of Plant Industry

In 1916, in the advertising circular of one of the commercial brands of peat, or "humus", appeared a recommendation that this peat be used on rhododendrons.

A chemical examination of a sample of the peat, in the light of several years experience with the behavior of rhododendrons in various kinds of soil, made it appear very questionable whether this peat would produce on rhododendrons the beneficial effect advertised. It was determined to try an experiment, which was conducted as follows:

Fifty-six healthy rhododendron seedlings were potted in two-inch porous earthenware pots, in a soil consisting of one part of clean sand and two parts, by bulk, of the advertised peat. Fifty-two other healthy rhododendrons seedlings of the same size, health, and history as the first lot, were potted in a soil consisting of one part of clean sand and two parts of upland kalmia peat, a mixture known from many experiments to be well suited to rhododendrons. The two series of pots were plunged in sand and placed in a greenhouse, under identical conditions of light, temperature, and watering.

The two lots of plants were photographed on November 21, 1916, four months after potting. In the mixture of upland peat and sand all the seedlings were in a normal healthy condition. (Plate 1, figure 1.) In the flat containing the advertised peat all the plants were dead. (Plate 1, figure 2.)

The significance of this experiment lies in the fact that the two kinds of peat used were fundamentlly different. The upland peat, in which the rhododendrons grew and thrived, was strongly acid in chemical reaction. The advertised peat, in which the rhododendrons died, was alkaline. This distinction is so important, so fundamental, agriculturally and horticulturally, that in this address I shall put still more distinctive labels on these two types of decaying vegetable matter by

[1] An address delivered before the American Peat Society at its meeting in Washington, December 8, 1923.

applying the name peat to the one that is acid, and muck to the one that is non-acid.

In hundreds of experiments by the speaker, extending over the past seventeen years, it has been shown repeatedly and conclusively that while the ordinary plants of agriculture thrive best in a soil that contains the non-acid muck, or its equivalent, there are many other plants that die in such a soil, both under cultivation and in the wild state. For thrifty growth they require peat or its acid equivalent.

Let us begin first with trailing arbutus. (There were then exhibiter and described colored lantern slides showing successful experiments in the cultivation of trailing arbutus, mountain-laurel, azaleas, blueberries, and many other plants, in peat soils. Special attention was given to the blueberry, which is now cultivated commercially. Varieties have been developed with berries reaching a diameter of 13/16 of an inch.) Four of these photographs are here reproduced. (Plates 2 to 4.)

Peat and muck deposits are used extensively for agricultural purposes in places in which they occur naturally. On true muck deposits, non-acid in chemical reaction, there is already a large and profitable industry in the growing of onions, celery, and lettuce. On true peat deposits, strongly acid in chemical reaction, there is also a large and profitable industry in the growing of cranberries, and a young and increasing industry in the growing of blueberries. Some of the most conspicuous failures in this class of agricultural industries have resulted from attempts to grow cranberries and blueberries in muck, and onions, celery, and lettuce in peat.

It is well known that acidity of peat can be neutralized by the addition of a suitable amount of lime. The question has recently been asked whether muck can be acidified artificially so that it will take the place of peat in horticulture. It is hoped that through a series of experiments, already begun, this question can be answered a year from the present time. Even now there are available the results of experiments with non-acid soils artificially acidified, which may be of interest to this audience.

(Here was given a summary, illustrated with colored lantern slides, of the experiments published in 1923 by the American Horticultural Society, under the title "The Effect of Aluminum Sulphate on Rhododendron Seedlings." [2] A non-acid rich garden soil, in which

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[2] The address of the secretary of the society is Battery Park, Bethesda, Maryland.

rhododendrons die, was found, after artificial acidulation with aluminum sulphate, to grow these plants with substantially the same luxuriance as peat.)

The experiments described and illustrated in this address teach a lesson of importance to the members of the American Peat Society, especially to those members who are producers of peat. The lesson is that there exists a horticultural place for, and a horticultural need of, true peat, strongly acid in reaction, and that if producers of peat are to occupy a proper relation to this need they must clearly distinguish this product from the non-acid peats. The agricultural classification of peats should begin with this distinction. The distinction is so fundamental and so important horticulturally that in my opinion non-acid peat when used agriculturally should be called muck, in order that it shall not be confused with true peat, the proper agricultural use of which is diametically opposite. It is essential that both producer and consumer understand that two fundamentally different substances are involved in their transactions.

Plate 1.

Figure 1. Rhododendron seedlings grown four months in one part of sand and two parts of upland kalmia peat. This mixture constitutes an acid soil in which rhododendrons grow in a normal, healthy manner.

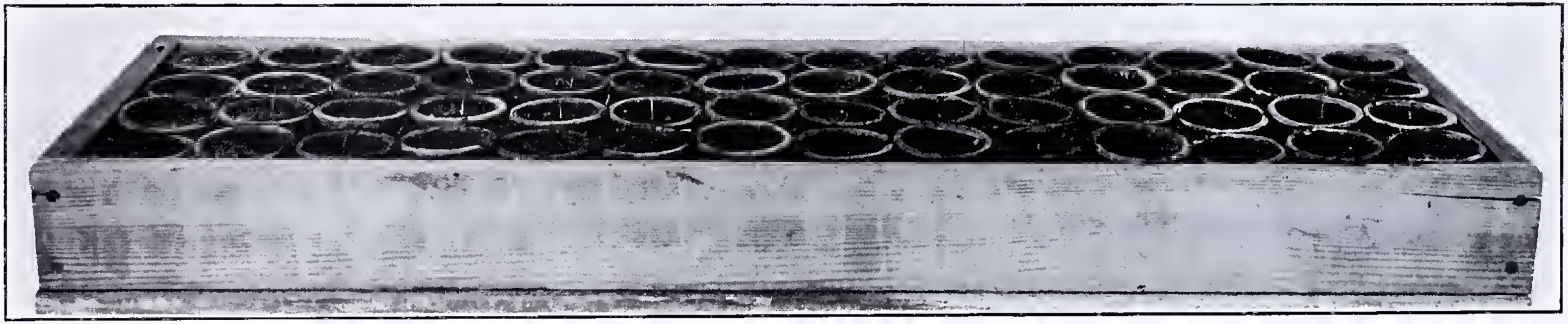

Figure 2. Rhododendron seedlings after four months in one part of sand and two parts of "humus" advertised in 1916 for use on rhododendrons. This "humus" was alkaline and all the plants had died.

Plate 2

Trailing arbutus (*Epigaca repens*) grown in the greenhouse, in an acid soil consisting of upland peat and sand. This plant is a male three-year-old seedling, in a three-inch pot. Its flowers are deep pink, the result of breeding from selected pink-flowered wild plants. Nine-tenths natural size.

Plate 3

A hedge of mountain-laurel (*Kalmia latifolia*), planted in an acid soil consisting of sand and rotten wood, and kept in an acid condition through a continuous mulch of oak leaves. This hedge borders the lawn of G. N. Collins, Lanham, Maryland.

Plate 4

A quart box of the Katharine blueberry, grown in acid, sandy, peat soil in the pine barrens of New Jersey. The largest of these berries is three-fourths of an inch in diameter. The berries of another and more recent hybrid have reached a diameter of over thirteen-sixteenths of an inch. Natural size.

THE UTILIZATION OF SPHAGNUM BOGS ON THE NORTHWEST COAST

George B. Rigg

University of Washington

During the last fifteen years the writer has investigated seventy-eight bogs situated along the Pacific coast of North America from Coos Bay, Oregon, to the Shumagin Islands in Alaska. Six of these bogs are in Oregon, 48 in Washington, 13 in British Columbia, and 11 in Alaska.

All of these bogs agree in having their surfaces composed of sphagnum moss. In the bogs that are in the earlier stages of development this moss is still living, while in those that are in later stages much of it is dead. The depth of the organic matter in them varies from about one foot to undetermined depths of more than 31 feet. The character of the organic material beneath the surface has been investigated with a Davis peat sampler, and has been found in the deeper bogs to be rather soft and watery, though in some cases brown peat of fairly solid consistency has been formed.

The organic material in these bogs rests on various substrata; glacial till, blue clay and sand being most common, though a few rest on gravel, rock, and soil formed *in situ*. They all, of course, occur in undrained, or poorly drained, depressions. They vary in area from less than one acre to approximately 15,000 acres, the largest ones being situated on the delta of the Fraser river in British Columbia.

The large area of these bogs makes their utilization an important consideration. It is impossible at present to make any exact statement as to the total area of such lands on the Pacific coast, but to say that there are in Oregon, Washington, British Columbia, and Alaska 100,000 acres of land mainly covered with sphagnum bogs, and the rest of it so essentally similar to these so far as substratum is concerned as to make the problems of their utilization practically the same, is to put an extremely conservative estimate on their extent.

The utilization of these bogs has so far been along three lines:

(1) utilization of the moss as such; (2) utilization of the peat as a constituent of fertilizers; (3) agricultural utilization of bog lands.

The living *Sphagnum* is used for absorptive dressing for wounds and for other absorptive purposes on the human body. Large numbers of surgical dressings were made on the Pacific coast from this moss during the World War and at least one firm is still making Sphagnum dressings designed for various uses. Of the large number of species of Sphagnum occurring on the Pacific coast, however, only four (*S. palustre*, *S. papillosum*, *S. imbricatum*, and *S. magellanicum*) are commonly considered suitable for these purposes, and these occur in comparatively few of the bogs. Many of the bogs examined do not contain any moss that is suitable for such dressings. On the other hand a few bogs contain a very dense growth of moss suitable for this purpose and the moss can be readily obtained from them in quantities.

The use of peat from these bogs as a constituent of fertilizers has, so far as the writer has seen, been carried on only locally and not on a commercial scale. The peat is very watery and so long as coal and wood are abundant in the region, its utilization as fuel is not a pressing problem.

Their utilization for the growth of crops has been largely along two lines: (1) truck farming, and (2) the commercial growing of cranberries. Bogs have been brought into cultivation as truck farms in the vicinity of Seattle, Washington, and Victoria, B. C. The writer has, during the years that he has been studying bogs, watched a bog just north of Seattle brought from the wild state into a high state of cultivation and productivity. The plants grown were mostly onions, celery and head lettuce. Carrots, parsnips and mangels, in addition to the crops just mentioned, are grown on reclaimed bogs near Victoria, B. C. Some agricultural utilization has been made of bog lands on Lulu Island near Vancouver, B. C.

The largest agricultural utilization of these bogs, is, however, for growing cranberries, such utilization being common in Coos County, Clatsop County and at some other points in Oregon, and in Pacific County and Grays Harbor County, Washington. The production of cranberries is not confined to sphagnum peat, other peat soils apparently being equally good.

In order to prepare a bog for agricultural utilization it must

first be drained. In many of the bogs this does not present serious difficulties, but a few so low that drainage is poor, and occasional ones in certain portions of the region are surrounded by rock, which presents more serious problems than the usual sand or glacial till.

After the bog has been drained, it is usually either scalped or burned. In scalping, the surface vegetation to a depth of a foot or so is cut into suitable chunks and removed from the bog, usually on wheelbarrows run on planks laid on the bog, the substratum being too soft to permit the use of horses. Burning is perhaps more common than scalping. Fire is set in the bog during the dry time in summer and burns only the surface, since the deeper layers are very wet. Burning has the advantage of being inexpensive and perhaps also the resulting ash may help in neutralizing acidity, and in other ways. It has the disadvantage that it burns deeper in some places than in others, so that a very irregular surface results, and some portions of the bog always escape burning. When good drainage has been provided and the bog has been either scalped or burned, the soil is usually stirred up in some way, frequently by spading, so that it is exposed to the air. After this, crops can be put on it, mineral fertilizers being required for some crops. The most successful crops on these bog lands are acid tolerant ones. Coville has pointed out the advantage of using acid tolerant crops on such lands.

The utilization of these bogs as cranberry marshes has developed a weed problem which in some particulars is peculiar to them. Bog and swamp plants tend to come into them either from seeds or spores or from vegetative parts left in the soil in preparing it for setting out the cranberry plants. Since it is impossible to cultivate these bogs after the cranberry plants have become well established in them, weeds (e. g. Field Horsetail) that have rhizomes spread rapidly in them if they once get a start, and in some cases valuable bogs are thus completely destroyed. Since the value of a producing bog is many times that of the land before the vines were set out, the destruction of the bog is a great economic loss.

The following plants have been found growing as weeds in commercial bogs:

Field horsetail (*Equisetum arvense*), water horsetail (*Equisetum fluviatile*), buckbean (*Menyanthes trifoliata*), skunk cabbage (*Lysichiton camschatcense*), yellow pond lily (*Nymphaea polysepala*), water celery (*Oenanthe sarmentosa*), silver weed (*Potentilla Anseri-*

na), fire weed (*Epilodium spp.*), cow parsnip (*Heracleum lanatum*), strawberry (*Fragaria Sp.*), rush (*Juncus effusis*), pearly everlasting (*Anaphalis margaritacea*), field sorrel (*Rumex acetosella*), hardhack (*Spircea douglasii*), and alder (*Alnus oregona*).

The most extensive injury seen was due to field horsetail. It is almost impossible to get rid of this plant when it once gets a foothold in the bog, except by tearing up the bog and setting out new plants. Next to this in point of injury is field sorrel. It is a bad weed but was not found in so many bogs as was field horsetail.

The observations on bog weeds were made incidentally to the study of the bogs in their wild state, and the list is incomplete. From the economic standpoint this subject merits more complete study.

The importance of reforestation tends to focus attention on the fact that the western birch (*Betula occidentalis*) grows readily in old bogs especially when they have been drained or burned. Undoubtedly birch forests could be produced in the older bogs of Whatcom county, Washington, where birch is abundant in the adjoining forests, by draining the bogs or both draining and burning and then allowing nature to take its course, or perhaps more effectively by preparing the soil more carefully and seeding them.

Most of the expense of the field work on these bogs was met by a grant from the research funds of the American Association for the Advancement of Science.

PEAT IN 1923

By K. W. Cottrell
U. S. Geological Survey

Returns made by the operators to the Geological Survey for 1923 indicated little change in the peat industry of the United States. Several companies dropped out of business, but new ones entered. The number of operators reporting for 1923 was 22, one less than for 1922.

The quantity of peat produced in the United States in 1923 was 61,355 short tons, valued at $376,834. This exceeded by 1 per cent the quantity produced in 1922; the value decreased 5 per cent. The quantity of peat sold for use as a fertilizer or as an ingredient of fertilizer increased less than 1 per cent over that sold in 1922, and the value decreased 5 per cent. The quantity of peat used as fuel in 1923 was negligible.

The 22 plants reporting the production of peat in 1923 were distributed as follows: California, New Jersey, and New York, 4 each; Illinois, Maine, and Michigan, 2 each; Florida, Indiana, Massachusetts, and Pennsylvania, 1 each. Illinois was the largest producer, but the state total may not be published, as only two operators reported. New Jersey ranked second, with an output of 18,380 short tons, valued at $107,885. California ranked third, with an output of 8,133 short tons, valued at $73,799.

Peat produced in the United States, 1919-1923, by uses

Year	Fertilizer and fertilizer ingredient		Stock food		Fuel		Other products [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1919	54,690	$557,240	6,402	$98,940	(2)	(2)	8,105	$49,352	69,197	$705,532
1920	63,272	773,635	[3] 9,182	[3] 143,047	750	$5,050	(3)	(3)	73,204	921,732
1921	29,460	251,046	[4] 946	[4] 9,073	(4)	(4)	(4)	(4)	30,406	260,119
1922	57,747	369,165	[3] 1,893	[3] 20,864	1,040	7,700	(3)	(3)	60,680	397,729
1923	57,907	351,641	[4] 3,448	[4] 25,193	(4)	(4)	(4)	(4)	61,355	376,834

[1] Peat moss, stable litter, and packing material. Also peat for fuel in 1919.
[2] Included under "Other products."
[3] Small quantity of miscellaneous products included under "Stock food."
[4] Small quantity of peat for fuel and miscellaneous products included under "Stock food."

Peat Moss imported for consumption in the United States, 1918-1923 [1]

Year	Short tons	Value	Year		Value
1918			1921	3,450	$22,754
1919	464	$16,345	1922	4,805	24,489
1920	2,762	36,201	1923	5,973	43,184

[1]Statistics of imports compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

The following individuals and companies reported to the Geological Survey that they produced peat in the United States in 1923:

Blaine, J. H., Hopewell Junction, N. Y.
Central Peat Corporation, Capac, Mich.
Chapman, I. S. & Co. (Inc.), 101 South E. Street, San Bernardino, Calif.
Craig, William N., Fishkill, N. Y.
Dow, Fred T., Bangor, Maine.
First Massachusetts Carbon Fuel Co., 306 Main Street, Worcester, Mass.
Florida Humus Co., Zellwood, Fla.
Humus Natural Manure Co., 1964 Broadway, New York, N. Y.
Hyper-Humus Co., Newton, N. J.
Keystone Humus Co., Hartstown, Pa.
Loskamp, P., Stockton, Calif.
McElhone, Asa, Fishkill, N. Y.
Manito Chemical Co., Peoria, Ill.
Marcrum, J. G., Netcong, N. J.
Moss Products Co., Jackman, Maine.
National Humus & Chemical Co., Chassell, Mich.
Pacific Humus Co., 802 Knickerbocker Building, Los Angeles, Calif.
Riverside Orange Co. (Ltd.), Arlington Heights, Riverside, Calif.
Sims, Alfred F., Sag Harbor, N. Y.
Standard Agricultural Chemical Corporation, 2 Rector Street, New York, N. Y.
Steenburg, W. C., South Bend, Ind.
Wiedmer Chemical Co., Pierce Building, St. Louis, Mo.

PEAT FUEL DEVELOPMENT

By Henry W. Hindshaw

Practically nothing has been done to produce, commercially, a peat fuel suitable for American requirements. Money in large amounts has been, and is being, squandered in trying over and over the same old experiments, namely, secret chemicals, electric treatment, wet carbonization, instantaneous dryers, and other means for performing some particular part of the treatment.

Apparently there has been no advance in the last twenty years. Exactly the same futile attempts were being made then as now, and with the same frequency.

Let us consider what has to be done.

Properly prepared peat has many excellent qualities. It is a low grade fuel according to the accepted coal classification, but it is at the same time a high class fuel, in non-technical English. Compared with the Pennsylvania anthracite now obtainable it has about the same thermal value. The fuel must be in an acceptable form, that is, a form easily handled by the shovel. It must be air dry and dense.

These requirements can be met by maceration or by briquetting. Many attempts have proved that briquetting is too expensive a process to be commercially profitable, while well made machine peat has so far been produced in such small amounts as to have no value.

The reasons for the long list of failures are easy to find. Generally plants have been engineered by some enthusiast who thinks that by his particular special device he has solved the whole problem, and who neglects to see that the one point covered is only a step in a long process.

No one, as far as I know, has approached the subject with complete engineering understanding, and provided for carrying out the whole process from excavation from the bog to loading the finished product for delivery to the user.

The necessary steps are about as follows, assuming a production on 100 tons per day for a 150 day season, 15,000 tons per year:

(1) Excavation of 80 to 90 per cent moisture material means digging from 100,000 to 125,000 tons for the season.

(2) Excess water, down to 70 per cent moisture, must be removed by drainage, after excavation.

(3) 300 tons per day must be handled into the mill; and,

(4) 30 tons per hour thoroughly macerated.

(5) The product discharged from the machine must be such that it can be handled by belt conveyors or other mechanical means.

(6) Provision must be made for placing on racks for drying, 300 tons per day; and,

(7) For keeping this on racks for an average of ten days, moving the material each day and exposing the whole surface to freely circulating air.

(8) 100 tons per day must be removed to stock piles or shipping bins.

Any one of these eight steps is as important as the other.

This is a matter of simple engineering in which there is no mystery. It is essential that the whole scheme shall be balanced.

The peat must be macerated much more completely than is usually considered necessary. This can be attained my milling in vacuo. The shape of the peat block must be such as to allow it to roll from a higher to a lower level on the drying racks.

With these conditions fulfilled there will be no difficulty in producing merchantable peat in large and profitable quantities.

We have not yet reached the point where we have to have peat fuel. When we need it badly enough we will get it. And it will require the same things that coal mining does, i. e., engineering and capital. The first step is public confidence in the engineer, and because of the numerous unsuccessful operations, past and present, it is hard to convince a business man that a profitable operation is possible.

NEWS OF THE SOCIETY AND THE INDUSTRY

Rhododendrons and Aluminum Sulphate

A method for making ordinary garden soil suitable for rhododendrons has been discovered by Dr. Frederick V. Coville, botanist of the United States Department of Agriculture, which although still in the experimental stage, will be welcomed by nurserymen and others interested in growing ornamental shrubbery. This knowledge is likely to be of importance at the present time when the importation of these plants has been greatly curtailed through the plant quarantine laws, and nurserymen are now trying to grow the needed plants inside the United States.

Native rhododendrons unlike most plants and crops require an acid soil and will not thrive in the ordinary fertile garden or greenhouse soil, but they grow with great luxuriance in sand mixed with peat, with rotting wood, or with half rotted leaves. Experiments have made it clear that rhododendrons thrive in this kind of soil because its chemical reaction is acid, and they die in the ordinary fertile soil because its reaction is neutral or alkaline.

Dr. Coville's experimental work which has been done in the greenhouse has shown that aluminum sulphate when applied to an ordinary soil is an effective and inexpensive method of changing the soil reaction from neutral or alkaline to acid. Where soils have been so treated the stimulation of growth of the rhododendrons has been very great, as much as 250 per cent increase in the diameter of the rosettes of seedling rhododendrons having been secured. Crude aluminuum sulphate is used in the chemical industries, is not expensive, and in large quantities can be purchased from dealers in chemical supplies at about $5 per 100 pounds.

Experiments that have been in progress for several years past have shown that soil acidity is required not only for rhododendrons but for azaleas, kalmias, and practically all the plants of the heath family, besides many orchids and numerous other plants of ornamental horticulture that are commonly regarded as difficult of cultivation.

There is every reason to expect, said Dr. Coville, that these other plants also can be made to thrive in ordinary soils through the use of aluminum sulphate.

Experimental work in this matter has not been carried on for sufficient length of time to be certain that long continued treatment with aluminum sulphate may not lead to the development of unforeseen difficulties, such as the formation of hydrogen sulphide or other compounds of sulphur injurious to this type of plants. For the present the aluminum sulphate treatment should be regarded as experimental.

Large rhododendrons growing in the deeper soils of outdoor plantings were not tested in these experiments, but for such situations, it is believed, amounts of aluminum sulphate up to half a pound per square yard may be applied advantageously and safely, if the soil is of the ordinary fertile type, the application being repeated if the soil is not made acid by the first application.

In an ideal rhododendron soil aluminum sulphate is unnecessary and useless. Persons desiring to experiment with sickly outdoor rhododendrons are advised to apply the aluminum sulphate to only a portion of the plantings, always leaving another portion untreated for comparison.—American Florist.

Danish Glass Works Fires Fed With Peat

The glass works at Holmergaard, in southern Denmark, lie in the center of a peat district. This fuel keeps the furnaces burning. Each year piles of peat are cut and stacked for the winter, the workers being Polish girls, who come for this purpose every summer and, this work being finished, remain in the district to hire themselves as harvesters among the neighboring farmers.—Linn, Mo., Bulletin.

World Power Conference Discusses Peat

The quantity of peat available in all the peat bogs of the world is one of the items being investigated this month by the World Power Conference, a congress of scientists gathered in London to consider what the world will do for a supply of fuel and power when the limited coal supplies now in sight have been exhausted. According to

Mr. G. K. Fletcher, a well-known British engineer, the amount of peat available is enormous, quite comparable with the world's known supplies of coal. The difficulty is that the peat is wet and has to be dried before it will burn. Drying is costly. Furthermore, the dried peat crumbles and is difficult to ship and handle. A fortune awaits the genius who will find a way to dry and burn peat on a commercial scale.

Mr. B. F. Haanel, of the American Peat Society, attended this conference, and while in Europe, inspected the various peat fuel plants.

Utah Considers Reclamation of Peat Land

Inspection of the agricultural lands in the delta of the Sacramento and San Joaquin rivers, California, has strengthened the opinion of R. A. Hart, senior drainage engineer, United States Department of Agriculture, that the peat lands of considerable acreage in Sanpete county, Utah, can be reclaimed at a low cost and made into a valuable producing section. Mr. Hart returned to his office in Salt Lake yesterday after investigating the similarity between the peat lands of Sanpete county and the delta visited, which, he said, is striking. So far as soil conditions are concerned, Utah has the advantage in having a peat soil which lacks acidity, but water conditions in the delta are more favorable to production, Mr. Hart said.

The first project proposed in the Sanpete peat lands is a reclamation unit of 4,000 acres. Mr. Hart holds to the belief, since visiting the California delta, that asparagus will be the best major product. Other crops grown successfully in the coast delta in straight peat soil are beans, corn, potatoes, onions and celery.

Conditions here require that a crop must mature early, have a short growing season, high water table in the spring, no supply late, and have a deep-rooting system. Such conditions are generally applicable to asparagus. Last year, Mr. Hart said, the delta he visited furnished 45,000 tons of asparagus, of which 39,000 tons went to canning plants. The best yield was 9,000 pounds an acre.

"If the Sanpete county land can be as successfully reclaimed as this delta land, it would stand a high reclamation charge, but as a matter of fact the charge would be low," Mr. Hart said.—Salt Lake City Tribune.

Peat Coke in Germany

Two Hamburg firms are taking peat from a 500-acre moor tract in the German Province of Holstein, and one firm's half is devoted to peat coke and by-products. Trade Commissioner W. T. Daugherty reports the annual production as 5,000 tons. As compared with wood charcoal the peat coke is stated to offer advantages for use in smelters, for glass-blowing and for use in chemical and metallurgical industries. It burns better and is more porous than wood coal. Containing little sulphur, it is adapted for refining iron and steel, and the peat-oil yields valuable by-products.

New Reclamation Project Proposed in Minnesota

A $55,000 peat soil and lake drainage project adjoining the southern city limits of Minneapolis, proposed to turn 600 acres of swamp land into truck gardens. Thirteen property owners in the Lake Nokomis region recently prepared to submit a petition for drainage to the board of Hennepin county commissioners Monday.

The petition affects three lakes, Mother lake, Mud lake and Duck lake, all within an area bounded by Lake Nokomis on the north, where drainage will be deposited, Portland avenue, Twenty-eighth avenue and Sixty-sixth street. Property owners who signed the petition, representing in all an area of approximately 1,200 acres, have organized the Mother Lake Drainage Association, with Martin Nelson, president, and J. M. Michaelson, secretary.—Minneapolis Journal.

BOOK REVIEW

THE OCCURRENCE AND USES OF PEAT IN THE UNITED STATES. By Soper, E. K., and Osborn, C. C. United States Geological Survey, Bull. 728, pp. 207 pls. 18 (10 maps), Figs. 32 (31 maps).

This report covers practically all the valuable peat areas in the United States, as well as nearly all the swamp lands, and is a valuable compilation of the data on peat for the whole country. The estimated resources of peat, computed on an air-dried basis, are 13,827,000,000 short tons, or a little more than that formerly estimated. Of the states containing valuable deposits, Minnesota contains by far the largest quantity, with Wisconsin, Florida, and Michigan following in order. Although there is so much peat in the country the annual production is comparatively small, only a little over 30,000 tons. The average value per ton for the year 1921 was $8.55. The chief use for peat is in agriculture. It is used in the raw state or in prepared fertilizers because of its nitrogen content, which runs from 1 to four per cent. and averages about 2 per cent. There are other minor uses for it in this country, such as stock feed, packing, and fuel and it is suggested that the United States might utilize to advantage some of the large deposits, well situated for exploitation, in the way that similar deposits are used in some of the countries of Europe. It is stated that peat coke is extensively used in Europe but not at all in America, although it could probably be produced here for about $4.00 a ton. Powdered peat has been experimented on in this country and found to be quite satisfactory for certain powdered-fuel purposes but so far it has not been adopted in practice.

Concerning the cost of producing peat for the market not much is said in the report beyond the quotation of the figures secured by the Department of Mines of Canada from experiments carried on previous to the year 1914. The figures for the cost of operating a few of the larger plants in the United States would have been interesting and valuable to many readers in throwing further light on production costs.

Brief discussions of the origin and the characteristics of peat are presented and a collection of analyses, partly new and partly com-

piled from other works forms a valuable part of this work. Peat deposits are classified according to the topographic conditions under which they originate and again as floral types. The authors recognize three topographic types and eight floral types of deposits. They also make four divisions on a basis of physical characters, these divisions comprising turfy, fibrous, earthly, and pitchy peats. The greater portion of the bulletin is taken up with the descriptions, necessarily brief because of the vast number of deposits involved, of deposits scattered from the Atlantic to the Pacific. The numerous maps accompanying these descriptions add much to their value and those interested in the peat resources of the country will find this bulletin a very useful addition to our literature on peat.

E. S. Moore

University of Toronto,
Toronto, Canada

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Address communications for committee to J. H. Beattie, McLean, Virginia.

SCOPE AND PURPOSE OF SOCIETY

The American Peat Society was organized at the national exposition at Jamestown, Va., on October 23, 1907, and was incorporated in 1912. It is an organization devoted to research and to the dissemination of information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat and muck.

Through its Advisory and Research Committee, consisting of botanists, geologists, chemists, bacteriologists, and engineers, the society will answer inquiries from members relating to the use of their deposits. There is no charge for general service.

NATURE AND USES OF PEAT AND MUCK

Peat and muck are residues resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas covered or saturated with water. They may be identified as the dark-colored soils found in bogs and swamps and in other low places. The commercial uses of peat and muck are varied. In the United States they are utilized chiefly as crop soils, as soil conditioners, and as ingredients of fertilizers. In some of the countries of Europe peat is used for fuel and is the basis for small manufacturing industries. Gas, charcoal, coke, and some by-products are produced in small quantities. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of litter, packing material and rugs, and selected varieties of peat moss have been used to make surgical dressings.

ECONOMIC ASPECTS OF PEAT

The United States contains over 12,000 square miles of undrained peat and muck land. The average deposit, if used for industrial purposes, will yield 200 tons per acre-foot. It is estimated that the deposits would be capable of yielding about 14 billion short tons of air-dried peat. Peat and muck areas are distributed throughout the Great Lake, Pacific Coast, and Atlantic Coast States. Peat and muck in Canada cover 37,000 square miles. According to published statistics, European countries annually consume about 50 million tons of peat fuel.

MEMBERSHIP

Present membership of the American Peat Society consists largely of agriculturists, engineers, and peat and muck land owners and producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetable matter, and in the production of fuel or generation of power, may join. Applications should be addressed to the secretary. Membership and subscription to the Journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS

Meetings of the Society are held annually in important cities throughout the peat regions. Papers are presented relating to the subjects enumerated. A quarterly journal, containing the proceedings of the Society, papers concerning all phases of peat, muck, and allied subjects and news of the industry, is published and sent to members. The scope of the papers is very broad, including the location of deposits, drainage and reclamation problems, methods of cultivation, fertilizer requirements, crop adaptation, cultural practice, physical and chemical characteristics, engineering practice, and production methods. One of the principal objects of the Society is the exposition of extravagant claims made by promoters.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society.

(Date)

MR. CHARLES KNAP, *Secretary-Treasurer,*
American Peat Society,
2 Rector St.,
New York, N. Y.

Dear Mr. Knap:

Application is hereby made for membership in the American Peat Society. Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This action is prompted by my interest in the science and utilization of peat and muck and the welfare of the society.

Yours very truly,

(Signature)

(Address)

CONTENTS

PAST PRESIDENTS
OF THE AMERICAN PEAT SOCIETY

Manuscripts sent for consideration by the editor should be registered. Written discussions of papers are invited. Authors wishing reprints of articles are requested to correspond with the editor. Advertising rates will be furnished upon application to the secretary.

Journal of the
American Peat Society

Vol. XVIII APRIL, 1925 No. 2

MR. OSBORN RESIGNS AS EDITOR OF THE JOURNAL

It is with sincere regret that the Society finds itself obliged to accept the resignation of Mr. Osborn as editor of the Journal. Pressure of private business affairs has compelled him to take this action and it will be a difficult matter to find one who can bring equal ability and devotion to the work. He has given freely of his time and has served purely from unselfish motives, as Mr. Osborn has never been financially interested in muck and peat. Moreover, he has always been a liberal contributor to the Society. Too much credit can never be given him for the altogether excellent manner in which the Journal has been handled during his term.

Mr. Osborn's many contributions to the study of muck and peat will long stand as milestones of progress in the consideration of the many problems associated with these great economic assets. Fortunately he will continue as a member of the Executive Committee, the Board of Councillors and the Advisory and Research Committee and the Society will have much of the support he has given in the past.

THE 1925 CONVENTION

An invitation was extended the Society at the 1924 convention held in Minnesota, by Professor Paul M. Harmer of the Michigan Agricultural College, East Lansing, Michigan, to hold the 1925 meeting of the Society at that place. Details of the convention are in charge of Professor Harmer, Muck Specialist of that institution. Details will appear in the next number of the Journal.

It is planned to hold the convention at the same time as the meeting of the Society of Agronomy, and a rare opportunity will be given for attending the meetings of both organizations. The time has not been determined but will be such that full advantage can be taken to study crop and soil problems to the best advantage.

Investigators who are working on the various phases of muck and peat utilization are earnestly requested to forward the titles of their papers to Professor Harmer. It is especially desirable that we have reports of original research work as it is believed that such work is fundamental to progress in this great problem.

MICHIGAN MUCK FARMERS' ASSOCIATION MEETING

Elsewhere in this number will be found an account of the meeting of the Michigan Muck Farmers' Association, held at East Lansing February 4th to 6th. The sessions were attended by from a hundred to a hundred and fifty actual muck farmers and the interest manifested was very great. This splendid organization is an example of what can be done in other states. At the last convention of our Society a committee was appointed to look into the matter of arranging for regional meetings which could be attended by persons who find it impossible to go to the national meeting. The wonderful work being done by the Michigan organization inspired the thought that similar associations could be developed in other states having large muck areas and suggested the possibilities of the regional meetings. Could these organizations follow the same general lines and methods of the Michigan Muck Farmers' Association it is safe to assert that immense good would be done in disseminating knowledge on the subject. Michigan is to be congratulated on this splendid organization.

CULTIVATION OF CROPS ON PEAT OR MUCK LAND*

By G. R. B. Elliott

Soil and environment are the two main factors governing the profitable production of crop. Of these two, environment usually is the more important. When both are distinctly favorable agriculture prospers and population develops. Of the two factors, soil is the more easily modified and from the earliest times has been modified by cultivation and the application of manures. Civilization developed when man modified climate in the sense that he modified the moisture conditions under which his crops were grown. The earliest civilizations of which there is any record are those developed around the production of rice in the tropics and wheat in the subtropics of the old world, and maize and manioc in the tropics of America. In his wild state, man picked his living where he could and no community idea was developed. In time he found that he could live better if he were more or less fixed in one locality where food was abundant. Where the food was produced by nature and could be had in large quantities merely for the taking, still the community idea did not develop. For example, it is claimed that man must have lived for centuries in one locality in order to have left the immense mounds of shells behind him, yet there is little evidence that he had developed more than the most rudimentary civilization. When he began to increase his supply of vegetable food, cultivation became necessary, and he was compelled to prepare the land for his planted crops. It would seem that he discovered that the easiest way to put his land in condition was to get it already cleared by nature and to alter the environment by changing the water supply. Then the rice civilization developed, in which man altered the supply of water from wet to dry, killing out wet land vegetation by drying the land and the dry land weeds by flooding. This method of cultivating the land required cooperative effort on a considerable scale and from this cooperation developed the first civilization of which we can find record.

Similarly the first civilizations based on the culture of wheat and

*Extract from paper read before the National Drainage Congress, St. Louis, Jan. 16, 17, '24, and entered as Minnesota Agricultural Experiment Station Paper No. 465, March 27, 1924.

manioc developed around the cooperative effort of irrigation. It is an astonishing reflection that through the first known cooperative effort by man and the first known application of natural science on what may be termed a tribal or social scale centered around drainage and irrigation. Yet it was not until very recent years that modern scientific principles were turned to supplying crops with water in proportion to their natural optimum requirements.

Water Consumption of Crops

While it is very easy to modify the character of the soil, environment is very difficult to control. Yet water is the most essential and critical of all substances assisting in the growth of the plant. Mineral matter is used only in small quantities. It is usually available and

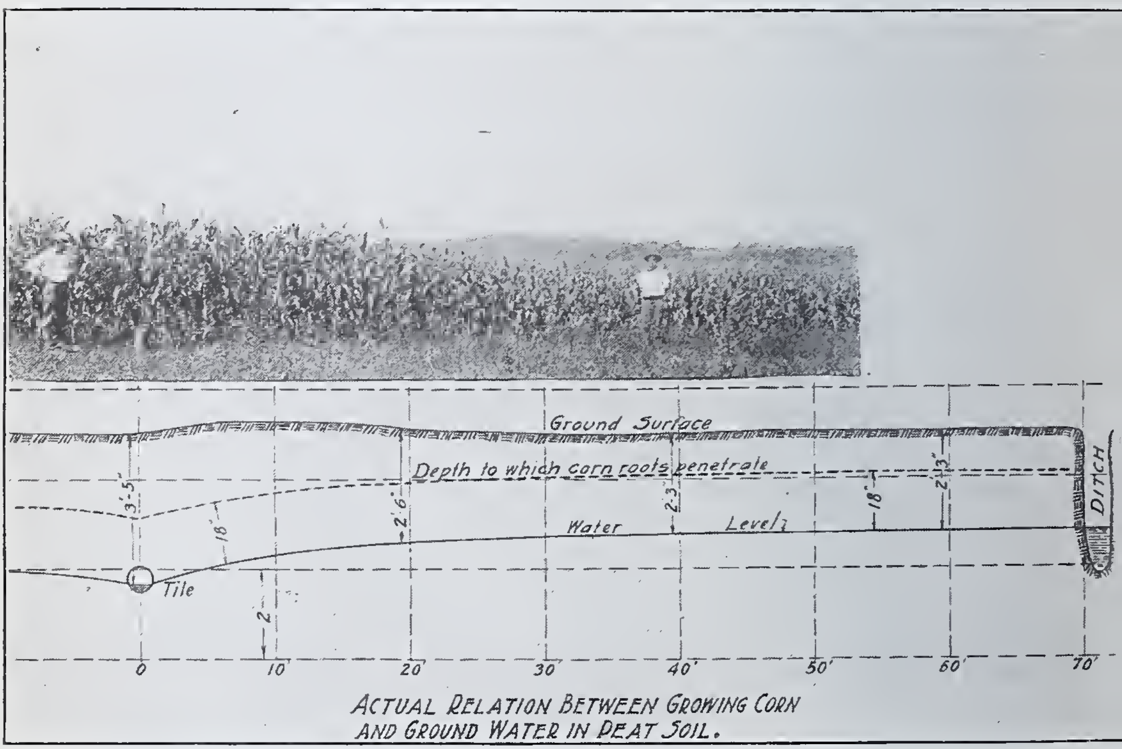


Figure 1. Actual relation between growing corn and water level on peat soil.

if not, can be supplied at comparatively small cost. Carbon dioxide is always present. Water not only enters into the structure of the plant itself but is a conveyor of all other material. The amount of water which passes through a crop plant during its life has been carefully ascertained by experiment. Under any given and uniform con-

ditions the amount of water transpired by the plant and the amount of dry matter produced are in quite definite ratio. But with the altering of conditions the ratio between consumption of water and dry matter produced may be very radically changed.

In ordinary soils the transpiration of water varies with different plants from 200 to nearly 800 pounds of water for every pound of dry matter produced by the plant. With any given soil and climate, if the amount of water supplied to the plant is just enough, then the maximum growth of crop will be produced for that soil and climate. If too little water is supplied, the plant is stunted. If too much water is applied, the roots are prevented from penetrating into the soil, root bed is restricted and the proper functioning of the plant is interfered with.

It is obvious that of under any given conditions of soil and climate the growing crop can be assisted or stimulated in the consumption of water, then that crop will be increased in the same ratio as the increase in water consumption. The ratio and manner of application will be dependent upon soil and environmental conditions and will vary within wide limits, the optimum being a matter to be determined by experimentation under those conditions.

Under most farming conditions only a slight control of moisture effected by surface tillage is economically possible. The crop uses what moisture is available and adapts itself accordingly. There are two types of land where moisture control is economically possible. These are the irrigated lands where a deficiency of moisture is remedied by an artificial supply, and the drained lands where a natural excess is artificially removed. Each can be made enormously productive. The drained lands, however, have a very distinct advantage. For the most part they lie near centers of population where transportation and markets are easily accessible, in this way making them suitable for heavy tonnage crops.

To this advantage of location, peat and muck lands add two others of very great importance. Peat and muck lands possess an inexhaustible store of nitrates and they possess an enormous capacity for storing water. Nitrates are the most expensive of all fertilizers to apply artificially, yet as long as they remain black, peat and muck soils contain ample nitrates for crop growth. Potash and phosphate are frequently deficient in peat soils and if lacking can be supplied at a cost which is very low compared with the productivity of the

soil. Water control becomes the outstanding factor in the development of the plant on peat or muck soil. Crops on peat or muck soils though they consume a much greater quantity of water than when

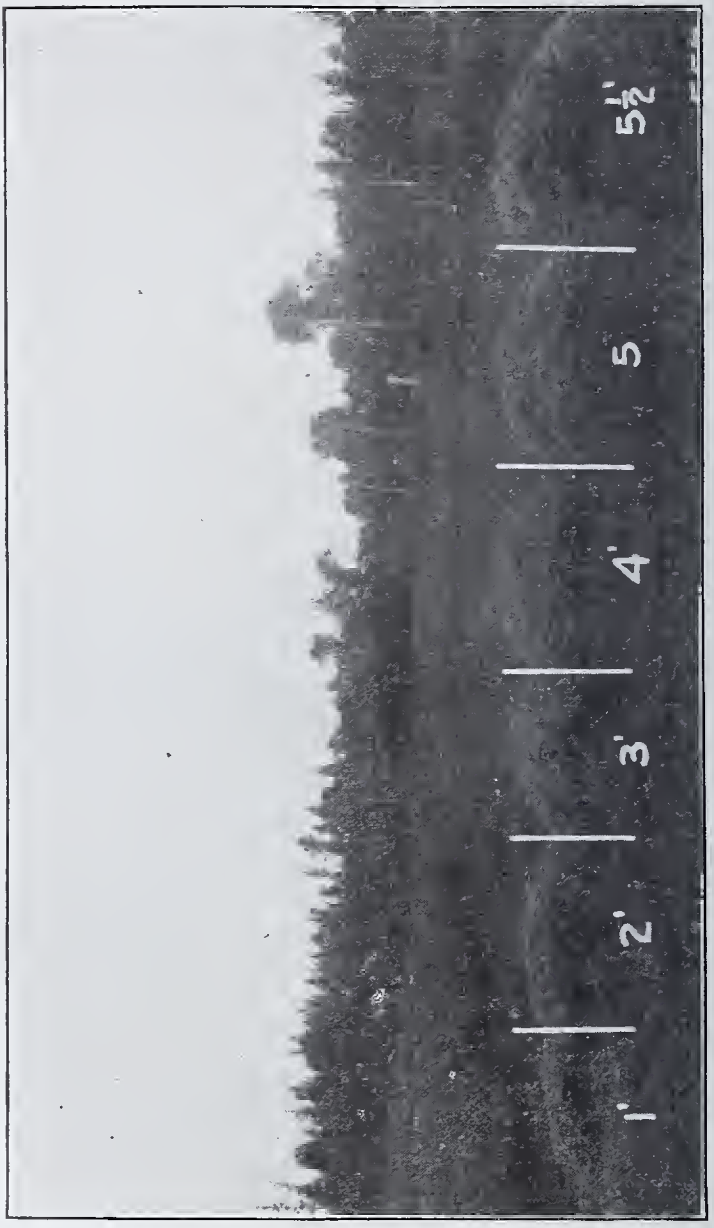


Figure 2. Growth of spring rye on similar areas of peat with the water held at 1, 2, 3, 4, 5, and 5½ feet below the surface. Purgo Peat Drainage Experimental Plots, Minnetonka, Minn.

growing on mineral soil are extremely sensitive to an over or improperly adjusted supply. If that supply is properly adjusted, an enormous quantity of moisture becomes available for crop growth.

How greatly moisture control may increase crop yield is indicated by the table at the end of this paper.

Upland and Lowland Bogs

There are two main classes of peat bogs which are very dissimilar in character. These are the upland bog, containing little

Figure 3. Part of the crop of rutabagas grown on peat which yielded 29.92 tons of roots per acre. Purgo Peat Experimental Plots, Minnetonka, Minn.

mineral matter, and the lowland bog, which has been subject to flood and consequently contains a comparatively high percentage of mineral matter. Of this mineral matter lime is usually the most important constituent. The upland moor will grow crops only after the application of lime. The roots of ordinary crop plants will penetrate into it only so far as the influence of lime penetrates. It is consequently very subject to drouth. For this and a number of other important reasons its cultivation should be undertaken with great caution.

The low marsh or muck swamp is very different. Movement of water by capillary power is very rapid and, if there is a supply of moisture at the bottom, it is practically impossible to overdrain it for ordinary farm purposes. Oxidation rapidly follows drainage and soil bacteria flourish.

Root Development in Peat

While a crop may grow on peat land, with the water level at almost any depth below the surface, yet the greatest root development takes place in a very definite zone, which differs for each type of plant and also with the character of the soil under cultivation. This appears to be controlled by two principal factors—oxidation and moisture content, the latter, in reality, controlling the former. In the soil on which experiments were conducted this year the roots of potatoes reached their maximum development where the dry matter content formed 71% of the peat. Where the moisture content increased to 75% or decreased to 65%, root development practically ceased. With the grasses the optimum condition seemed to be at the level where the moisture contact was 73% and the zone of proper development was even narrower. With the lower water levels, it appeared that the young grass roots could not penetrate the dry top soil which developed over these levels as soon as the weather began to warm up during the summer.

Other things being the same, it is evident that the greatest crop growth will be produced where the roots have the greatest thickness of the most suitable root bed, most easily accessible. The easiest way to modify the moisture conditions in the soil is by a control of the subsoil water level. To determine the most suitable water level for ordinary crops and also to determine if yield could be influenced by moisture control, experiments were carried out during the past three years at Purgo Peat Experimental Plots, Minnetonka, Minn. It was found that yield was influenced from 50% to 400% by water level

Figure 4. Relation between corn plant and water level in peat showing flattening out of roots in definite zone.

control alone and in certain cases much heavier yields were produced than were expected.

Effect of Drainage

One would naturally assume that the best crops to grow on peat or muck soil are those which consume a large quantity of water. In general this is true. But it is also true that some of the crops that use a large quantity of water are also sensitive to an over-supply. This was particularly true of the so-called root crops such as beets, rutabagas and carrots. On these crops, though a heavy growth might be produced on the higher water levels, the moist soil promoted the growth of lateral roots and the formation of "fingers." It was not until the 3-foot level was passed that the roots became of normal shape.

Similarly, beans which gave a very heavy top on the upper levels kept on growing until frost killed the plants. Consequently many immature beans were threshed and proportionately reduced the value of the yield.

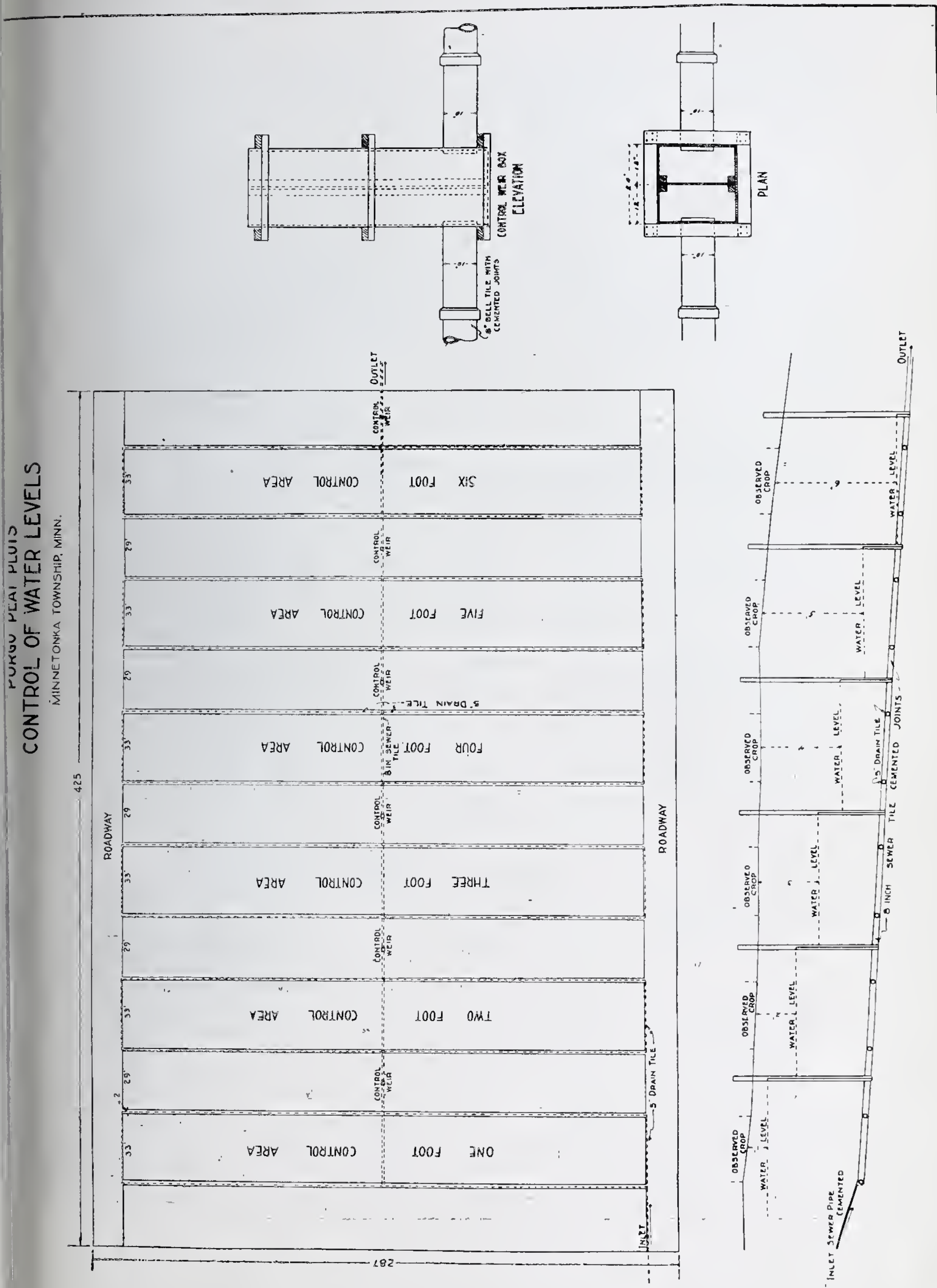
Hay crops without exception gave the heaviest crops on the upper levels. There was a compensating disadvantage to this for if the water is held less than three feet from the surface the crop is hard to harvest. Winter-killing of grasses and clover is also very serious on the wet peat.

Cabbages gave outstandingly better results both in quantity and quality where the water was held three feet below the surface.

Corn gave the best growth of stalk on the 4-foot level, but the best ears on the 5-foot level. The larger ears were, however, longer in growing and a larger proportion got frosted. The figures for yields are consequently misleading if taken without explanation.

Potatoes gave outstandingly the best results of all field crops. Two varieties yielded at the rate of more than a thousand bushels per acre and were of very fine texture and table quality. The rapid growth, however, made them knobby and irregular. Early Ohios were the worst in this respect and Bliss Triumph and Cobbler the best. Early varieties of potatoes gave the best yield with water held 3 to 4 feet below the surface, while later varieties produced more heavily on deeper levels.

From the above facts it appears how great a variation in crop may be produced by variation in water level and it is probable that even greater growth and yield could be produced by carefully watch-



No. 5. Layout of Sub-irrigation Experiment Station in Peat. Purgo Peat Plots, Minnetonka, Minn.

ing the moisture content of the soil and carefully regulating the water level according to season and the amount of rainfall.

PURGO PEAT EXPERIMENTAL PLOTS, MINNETONKA, MINN.

YIELDS OF POTATOES IN BUSHELS PER ACRE GROWN ON PEAT LAND WITH CONTROLLED SUB-IRRIGATION, 1923

VARIETY	WATER LEVELS IN FEET				
	1	2	3	4	5
	Fertilized with potash phosphate and barn manure				
1. Early Ohio, U. S. No. 1	159.5	319.0	352.0	363.0	352.0
2nd merchantable and culls	141.3	254.8	245.7	308.0	295.2
Total	300.8	573.8	597.7	671.0	647.2
2. Burbank Russet, U. S. No. 1	152.2	359.3	416.2	366.6	363.0
2nd merchantable and culls	128.3	302.5	366.6	322.3	328.2
Total	280.5	661.8	782.8	688.9	691.2
3. Green Mountain, U. S. No. 1	337.3	440.0	454.7	462.0	473.0
2nd merchantable and culls	292.3	524.3	528.0	528.0	539.0
Total	729.6	964.3	982.7	990.0	1012.0
4. Triumph, U. S. No. 1	414.3	542.7	597.7	630.7	652.7
2nd merchantable and culls	359.3	443.7	560.0	601.7	601.7
Total	773.6	985.4	1157.7	1232.4	1253.4
	Fertilized with potash and phosphate and infected with disease				
5. Irish Cobblers, U. S. No. 1	245.7	272.2	405.2	396.0	366.6
2nd merchantable and culls	34.8	44.0	38.3	42.2	42.2
Total	280.5	316.2	443.5	438.2	408.2
	Same as No. 5 treated with inoculated sulphur				
6. Irish Cobblers, U. S. No. 1	196.2	287.8	214.5	236.5	212.7
2nd merchantable and culls	60.5	53.2	51.5	45.7	38.5
Total	256.7	314.0	266.0	282.2	251.2
7. Early Ohios, U. S. No. 1	185.2	276.8	319.0	311.8	341.0
2nd merchantable and culls	45.8	45.8	51.2	45.8	42.2
Total	231.0	322.6	360.2	357.6	383,2

YIELDS OF CROPS GROWN ON PEAT WITH CONTROLLED SUB-IRRIGATION, 1923

CROP	WATER LEVELS IN FEET				
	1	2	3	4	5
Timothy & Clover, tons	1.98	4.62	4.36	4.24	3.96
Med. Red Clover, broadcast	1.57	2.02	1.65	1.98	1.98
Med. Red Clover, drilled	1.15	3.13	3.46	3.86	1.32
Oat Hay	3.74	4.51	4.29	4.07	4.40
Corn Stover, drilled	7.59	7.98	10.23	11.99	11.44
Corn Stover, checked	5.91	6.89	6.65	7.86	6.05
Corn Stover, (shelled) grain, bu.	29.5	31.4	60.1	49.9	57.7
Rye, bu.	17.1	20.3	20.0	22.5	25.9
Flax, bu	6.35	7.16	12.76	12.00	12.38
White Navy Beans, bu.	109.26	141.10	147.56	128.17	134.96
Brown Beans, bu.	83.07	126.55	132.85	116.64	118.32
Cauliflower, tons	3.05	1.12	1.59	7.13	6.71
Cabbage, tons	18.92	30.36	23.32	23.86	24.64
Chinese Cabbage, tons	15.73	14.08	22.44	22.44	24.62
Mangels, tons	23.32	23.54	25.54	23.10	20.24
Rutabagas, tons	17.60	27.72	24.20	25.52	29.92
Sugar Beets, tons	11.88	12.42	12.08	20.02	19.80
Per cent sugar	16.6	18.5	17.4	17.3	18.6

Forage yields weighed in the field. Grains and seeds dried in hot room of seed storage before weighing.

SOME ASPECTS OF TRUCK GROWING ON PEAT LANDS IN MINNESOTA*[1]

By F. A. Krantz

Section of Vegetable Gardening, Minnesota Experiment Station

Cultivated crops on peat lands are necessarily intensive crops. Peat lands require considerable capital and labor per acre, and demand special treatment, consequently the crops grown must give returns commensurate with these costs. Truck crops conform to these conditions and for this reason, wherever peat lands are under cultivation, there we find important truck crop centers. In Minnesota the beginnings of such truck crop centers is coincident with the rapid development of the peat lands. Climate, soil, and proximity to market, all favor the industry of truck cropping, particularly of those crops adapted to cool seasons. The history of the truck crop industry in Minnesota will be a history of the development of the peat lands.

The limiting factors in the growth of crops on peat lands is frequently the exact reverse of the factors limiting plant growth on upland soils. The growth conditions on these two types of soil in the same locality differ to a greater or lesser degree in temperature, moisture, length of growing season, fertilizer requirements, types of weeds, disease pests, and soil texture. It is not surprising that cultural practices which give success on upland soils more often resulted in failure when applied to the adjacent peat land. Those vegetable crops which are classed as cool season crops can be more satisfactorily grown on peat soils than on the adjacent upland. But the methods used in growing these crops must be adapted to peat land conditions. A few examples will make clear this point.

Our present varieties are in existence because they are adapted to the environmental conditions prevailing on our mineral soils and are supplying a certain market demand. Fortunately certain of these varieties are adapted to peat lands as well. Some are far superior when grown on this type of soil. Preliminary tests indicate that it will probably not be difficult to select from the standard varieties of certain cool season crops, such as lettuce, celery, onions, potatoes,

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[1]Paper read at the 18th Annual Convention of the American Peat Society.

cabbage, cauliflower and carrots, varieties which are more or less adapted to peat land conditions. However, varieties more adapted to local peat land conditions are needed. For example, the crisp varieties of head lettuce respond somewhat differently under climatic conditions of Minnesota peat lands than when grown in the Imperial Valley of California. The climatic conditions appear to be too unfavorable for their growth as they frequently develop a large loose head which lacks the necessary compactness that the market demands. A smaller, firmer headed strain of the New York type would be desired. The potato is well adapted to peat lands in this state. The three leading standard varieties of this state, namely the Green Mountain, Rural New Yorker, and Early Ohio, however, are not adapted to peat land conditions, but the less important standard varieties, as Cobbler, Triumph, and possibly the Burbank Russet, may be grown successfully. An early maturing variety with the superior tuber characters of the late standard varieties is needed for peat soil.

Nutrition problems on peat soils are of great importance and of peculiar interest. In the past, investigators have directed their attention for the larger part to the role which nitrogen plays in the nutrition of plants, due to the fact that on mineral soils nitrogen assumes a role of major importance. On peats, however, different problems are presented since peats are largely of vegetable origin. Here the application of mineral elements is the most important. Since mineral elements must be applied on peats, it is important for the grower to know the amount of each to supply, to secure the most beneficial results to the crop. Due to the lack of information concerning the requirements of most vegetable crops as regards mineral elements the grower is usually advised to apply twice the amount that a good yield would withdraw from the land. The amount withdrawn is calculated on the basis of the amount of mineral elements present in the crop when grown on mineral soils. This may or may not be a reliable guide. Studies should be made to secure a method to determine when a crop is lacking a sufficient amount of an element before it seriously reduces the yield.

Other problems, a few of which might be mentioned, have arisen. Considerable loss in celery has occurred during the past crop season due to the formation of seed stalks the first season. This condition was not limited to peat lands. Since, however, celery is grown mostly on peat lands it assumes major importance to the peat land grower. It has been demonstrated that when plants are kept at cold tempera-

tures previous to transplanting, that this condition will occur. It necessitates a study of preventive methods especially as related to means of preventing continuous low temperature in the cold frame. Another very serious loss occurred in the onion crop. The simultaneous growth of the flower primordia with the development of the bulb causing a thick-necked condition, was very prevalent. A similar tendency of the onion to lay down its flower primordia occurred on the upland though to a far less degree. In this case it weakened the keeping quality of the bulbs. The greater part of the onions had apparently no dormant period. As this condition did not occur in previous seasons, it was probably due to a combination of climatic and soil factors. It would be desirable to make a determination of the exact factors involved in causing this response in the onion plant, with the view of ascertaining means of mitigating the losses in the future.

The citizens of St. Louis County, Minnesota, have recognized that accurate information is needed by the vegetable grower located on the peat lands of that locality in order for him to realize to the fullest extent the returns for his industry. They have supplied during the past season the financial means which has enabled experiments to be conducted at Fens, Minnesota. The objects of these experiments have been to determine:

1. The vegetables which are adapted to the peat soils of that locality.

2. The most suitable varities of these vegetables.

3. The effect of different plant foods, namely nitrogen, potash and phosphorus, and sulphur, on the growth, development, and quality of the different crops. Special study is being given to the amount of these plant foods to apply in relation to each other, in order to secure the desired effect on a particular vegetable.

4. To study the efficiency of different cultural methods. The advantages which peat soils possess over mineral soils for the growing of vegetable crops are so marked that the vegetable industry in Minnesota will be undoubtedly located on this type of soil. The rapidity with which the trucking industry is being developed indicates that Minnesota is destined to become an important truck crop producing state in the near future. It has therefore been considered advisable to call attention to some of the problems which are arising and the need for information concerning them.

RELATION OF WATER TABLE TO FLOW LINE OF DRAINS

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Treatises on land drainage usually represent the surface of soil water between ditches as a curve, with the ends resting on or near the water surface in the ditches and rising midway between ditches to or near the surface, at the time of or soon after heavy rains. As the water table falls, due to the action of the drains, the surface is supposed to gradually approximate a straight line connecting the water surface in the ditches.

Investigators studying the effect of drainage on crop yields are liable to assume either the grade line of the ditches, represent the ordinary water table through the growing season, or it is represented by a curve with the ends at the grade of the ditches and the middle ordinate at a height equal to the height of the water above the ditch grade, as shown in an observation well located midway between the ditch lines.

An extended experience in the use of observation wells would indicate that there are frequent conditions and characteristics of soils which prevent the water table in drained land following the usually accepted theory of a curved line or of rapidly approximating the grade of the drains after rains during the growing season of the ordinary year.

In 1907 a large number of observation wells were located on nine miles of tile drains on the Northwest Experiment Farm in the Red River Valley in Minnesota. The result of readings taken on these wells in 1908 and 1909 were so erratic that it was decided no information of value could be obtained and their use was discontinued. The land was apparently a flat uniform tract of land with a fine textured soil formed in water of the same characteristics many feet in depth.

While investigating the value for agriculture of a deep peat swamp on the North Central Experiment Farm in Minnesota, a number of observation wells were located with a view of determining the water table throughout the crop season. Readings on these wells

varied considerably from what might have been expected through the influence of the tile grades.

In the spring of 1923 F. J. Alway requested the writer to prepare the specifications for the drainage of a series of plots at the Coon Creek Peat Experimental Fields of the University of Minnesota,* upon which he wished to be able to hold the water at different depths in order to determine the effects of these upon various crops. There were 6 plots, each 100 feet by 200 feet, separated by buffer plots of the same dimensions. On these plots the water was held at 1, 2, 3, 4, 5, and 6 feet below the surface. Controls were placed in the ditch so that the surface of the water in the drain could be held at these depths as long as desired.

This tract was a well decomposed peat underlaid by fine sand. Observation wells were located in the center of each plot, sunk from the surface through the peat into the sand. Four other observation wells were located, one midway between the center well and the drainage ditch in each direction, sunk from the surface to a depth somewhat lower than that at which the water was to be maintained in the adjoining drain but not through to the sand. The summer of 1923 was exceptionally dry but at no time did the water table, as indicated by the observation wells, fall to as low a level as that in the ditches where the drainage was greater than 2 feet while in the one and two foot plots, there was a tendency at times for it to stand lower than in the ditches. Furthermore, all wells extending into the sand indicated a higher water level than adjacent wells in the peat.

In the spring of 1924, in an extra effort to reduce the water level in the plots to the elevation planned for the experiment, some of the ditches were deepened into the sand and relief wells provided. Although the earlier part of the season was dry the water did not fall to the desired elevation where the drainage was greater than 4 feet and fell too low where drainage of only one foot was wanted. Throughout the season all the wells in the sand showed a greater water elevation than those in the peat. To secure a better check on the surface of the ground water, observation wells through to the sand were located 10 feet apart along the center line in two directions of the 6-foot drainage plot. It was found by these wells that the water table in both directions across the plot remained approximately parallel to the ground surface, even in the wells located only 10 feet

*The writer is indebted to the Division of Soils of the University of Minnesota for many of the readings of the wells upon which figures 3 to 6 are based.

from the center of the ditches. At one time the water in one of the wells stood 4 feet higher than in a ditch 10 feet distant cut into the sand and at no time during the season was it less than 1.5 feet higher.

Conclusions

1. That under ordinary soil conditions and characteristics, the depth of the water table may be expressed by the depth of ditch grade below surface elevations.

2. The depth of water table as indicated by an observation well may vary considerably from that computed from ditch grades due to small stratas or veins of sand, openings in the soil made by insects, small animals, plant roots and other causes.

3. The water table may lie parallel to the ground surface at a distance considerably above that to be expected from the depth of ditch and in places may fall below the water level in the ditches.

4. A number of observation wells at close intervals in the proximity of the drains are necessary to determine the position of the water table at any given time.

5. In determining the value of the depth of drainage on crop yields, due consideration should be given to rainfall. A condition of rainfall could cause a given depth of drainage for one or two seasons to make a marked increase or decrease in crop production.

6. In fine textured soils the water table does not adjust itself to ditch grades as readily as in coarse textured soils.

7. The movement of soil moisture in wet peat is very slow and in dry peat very rapid.

8. Water is retained in most of the peat soils by hydrostatic pressure and capillarity.

9. Evaporation rapidly drys the surface of peat soil. The avidity of the peat for water causes moisture to raise to the surface to supply that lost. If water is not available to supply that lost, the peat cracks as it dries and the circulation of air through the cracks greatly facilitates the drying process.

10. When the water table in peat soil is lowered to the point where capillarity cannot raise sufficient moisture to the surface the soil is overdrained.

11. So long as the drains do not release the hydrostatic pressure below the point where capillarity can bring sufficient water for plant growth to the surface, there is no danger of over-drainage.

12. Ditch grades laid in open porous material under peat have

been effective for long distances, even as great as one-quarter and one-half mile, and under such conditions there is danger of over-drainage.

13. Ditch grades in peat or fine material holding water under hydrostatic pressure have not lowered the water table to the ditch grades a few feet away and there is no danger of overdrainage so long as the hydrostatic head is maintained.

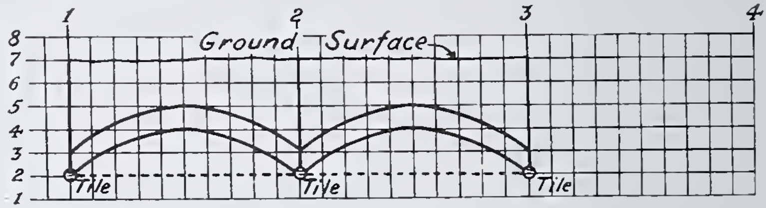

Figure 1. Relation of water table to drains in tiled land as usually shown in drainage literature.

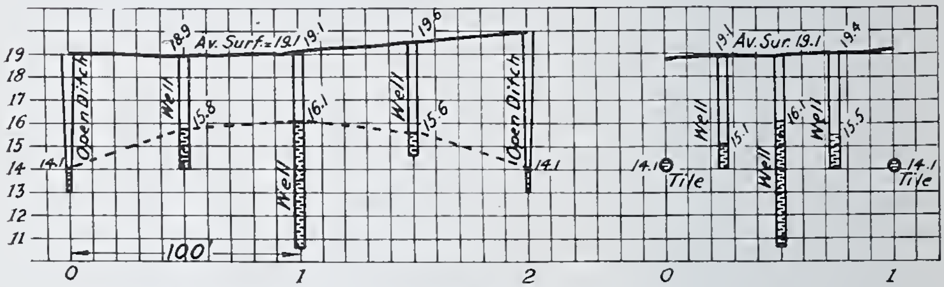

Figure 4. Profiles at right angles across center of plot, of peat underlaid by fine sand showing elevation of water surface in drains, one observation well through to sand and two observation wells in peat.

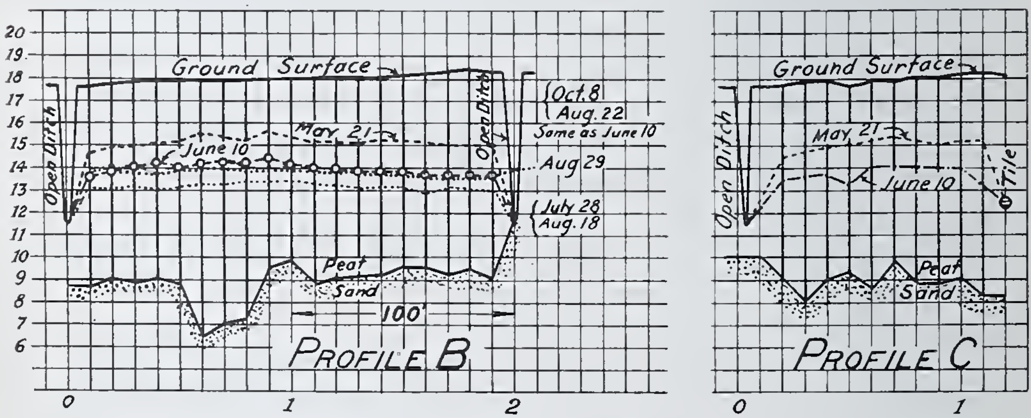

Figure 5. Profiles at right angles across center of plot showing water table on different dates with wells 10 feet apart.

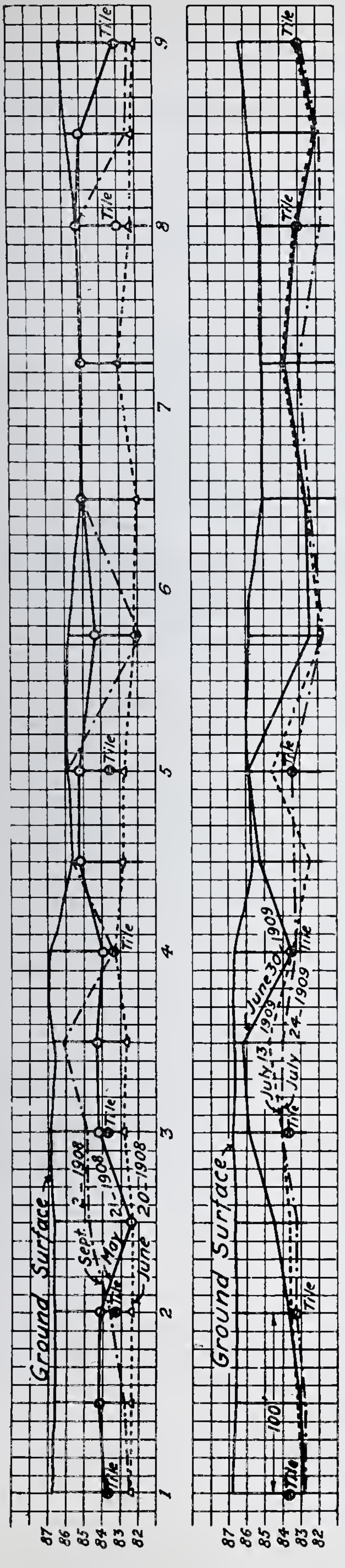

Figure 2. Water Table in tiled mineral land as shown by observation wells on various dates at the Northwest Experiment Farm, Minnesota.

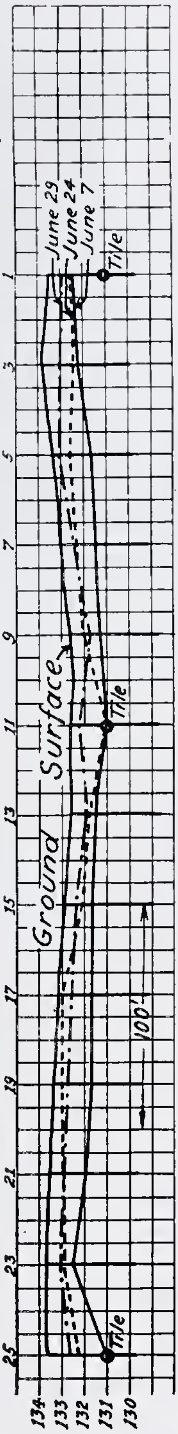

Figure 3. Water Table in tiled peat land as shown by observation wells on various dates at North Central Experiment Farm.

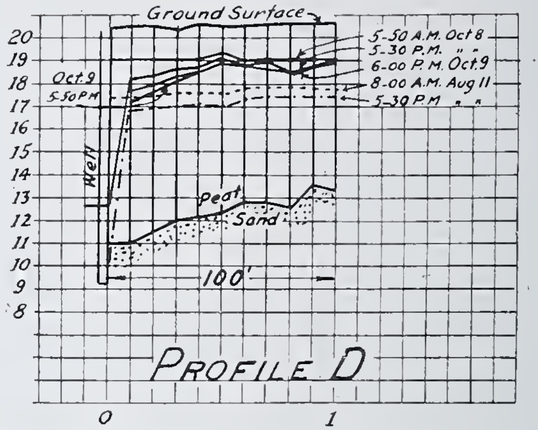

Figure 6. Showing fall of water, with pump running, in observation wells spaced 10 feet apart from a 4 feet x 6 feet wall, all sunk into the sand.

THE RELATION OF PEAT TO OIL SHALE[1]

By S. Linker

Poor and cheaper grades of fuels other than petroleum and coal are very plentiful in the United States, but they have not been used here as much as in other countries. Peat and lignite are used in Germany and the Netherlands, either directly for fuel or else distilled for their oil content, a very wasteful process. Peat beds cover large areas in this country, the two main regions being near the Great Lakes and the Atlantic coast. Lignite is also found in sufficient quantities to be mined in many regions of the United States, and so located that they can easily be reached when the time comes to use them. However, not in a thousand years will it be necessary to turn to these deposits as our main source of fuel. This statement is not meant to be disparaging to the peat industry, but rather the remark is made to show that at the present time a better and more economical source of fuel is known. Peat is much too valuable to the agricultural industry to be wasted in distilling it for its oil content.

It is not necessary to use these low-grade fuels because we have within our boundaries hundreds and hundreds of acres of valuable rock which would yield a liquid fuel on distillation. These oil-shales occur in large deposits in the eastern section in Illinois, Indiana, Ohio, Pennsylvania, Kentucky, and Tennessee; in the Rocky Mountain region in Colorado, Utah, Wyoming, Nevada; and in the Pacific Coast region in California. These deposits are so situated that they can easily be mined, distilled, and the oil refined. The refined oil can easily be piped to local centers where it may be stored or used directly for various purposes.

Upon distillation, some of the oil shales found in this country yield as much as 90 gallons of oil per ton, but the average yield is between 20 and 30 gallons. This distilled oil when refined produces gasoline and valuable by-products. The price of well oil is much too low to consider the problem of distilling oil shale at the present time in competition, but when the well oil price will rise to $3 and $4 per barrel, and the shale oil would be gotten for $2 and $2.50 per barrel, the time will be ripe for the extensive and intensive development of the

[1]Delivered at the 17th Am. Con. of the Amer. Peat Society, Wash., D. C., Dec. 8, 1923.

oil shale industry from a commercial point. So one can see that to distill peat and lignite at the present time is not a paying proposition.

It is interesting to note the varieties of oil shale which are known to exist and to contain a high percentage of oil. The samples shown were lent to the speaker by Dr. David White of the United States Geological Survey and were the three common types found in the Green River formation in the Rocky Mountain region. These were the contorted shale with a velvety appearance, the thin paper shale resembling the curled up leaves of a book, the massive black shale resembling a piece of rubber, and a less common type which showed the bedding planes very clearly. The other samples were from Elko, Nevada, a light bluff colored shale, showing distinct lamination; and from Brazil, a shale which appears like a petrified piece of peat.

From all appearances these shales seem to have been formed under different conditions. The petrographic study of oil shales is most interesting, and thin sections placed under the microscope present many curious features. When cut very thin, the color of the shale ranges from yellow to reddish brown. Thin laminae are visible in most of the shales, curving gently above and below the embedded bodies. The composition as seen under the microscope is of (1) visible well-preserved plant material such as spores of various kinds, spore coverings, sporangium cases, fern annuli, pollen grains, fragments of cell tissue, and even some algae, fungi and bacteria; (2) some macerated organic residue; (3) small pieces of resin, light yellow or reddish in color; (4) some animal fossils, especially in the Austrian shales where the foraminifera shells are abundant, and the Bulgarian shales which contain many remains of entomostraca allied to the crustacea; (5) small flat spherical or lense shaped translucent bodies, more or less wrinkled; (6) some mineral matter in the form of sand grains, clay particles and pyrite specks. All these materials seem to be embedded in a ground mass an undifferentiated amorphous material which very frequently is yellowish in color, though sometimes the color may be a dark brown or black as in the cannel shales of South Africa.

The interesting phase of the study of oil-shale is its origin. As to the formation of the oil shale, many theories have been presented. It is generally believed that mud and sand were laid down in water in which the various parts of plants were preserved more or less, and embedded in the soft muddy deposit. The microscope examinations substantiate this theory, which is a very simple explanation for such complexity of characteristics as shown by the shales found in the Eastern

and Western regions of the United States, Scotland and Bulgaria, South Africa and Brazil, Austria and New South Wales.

The subject of peat and bog water throw some light upon the origin of the oil shale, beyond the question that the organic and mineral matter being laid down in water. Peat has been formed and is forming whenever conditions are favorable to the luxuriant growth of plants and where partial decay of the dead vegetation would take place. The peat bog, marsh, or swamp in geologic ages past, also had open areas of water, whether fresh or salt, which furnished the materials for the original deposit which today we find as oil-shale, and from these swamps with their luxuriant vegetation came the supply of the organic matter found in the present deposits of oil shale. Parts of plants floated out into quiet water, and then they gradually sank to the muddy bottom. Mingled with this vegetable debris were living bacteria, fungi and algae. Today we find by test borings, at the bottom of deep peat deposits, a fine-grained rubber-like layer formed from the decomposition of the algae. It is known as algal peat or dopplerite, and its formation is very slow.

The interesting and puzzling point in the study of the origin of the shale deposits, is what happened to the water-soaked material on its way down to the bottom, and what action went on or took place once they reached bottom. Certain parts of the plants will decay more rapidly than others. Those parts which contain or are covered with a resinous coating are more resistant and therefore are preserved longer; also they are lighter and are carried out farther into the open area of water and gradually they also sink to the bottom.

It appears that before lithification occured, a chemical action took place which changed the softer tissues of the plant debris, breaking down the chemical composition of those and rearranging the elements into another form of organic matter. which would appear like a jelly, as is seen by layers at the bottom of deep peat bogs which have been converted into a jelly-like substance of a colloidal character. In the ancient deposits, this colloidal matter had penetrated and filled the more resistant fragments, thus preserving them from further decay.

The medium in which the vegetable debris was laid down was bog water, and again we can turn to the peat bog of today for some comparison. Certain bogwaters carry a high percentage of humus acids in solution or else as colloidal matter in suspension. These acids are soluble in water but insoluble in hyrochloric and sulphuric acids; when neutralized with bases, they produce humates which are insoluble in

water. Considering that the water of some ancient swamp also contained humic acids in even greater quantity because of the climate and amount of vegetation at that time, the humic acids must have been precipitated under certain conditions by various agents which are active today. It seems from microscopic examination of the various oil shales, that probably bacteria might have been the catalyzing agent and the humates, which were formed through bacterial activity would naturally take the form of small, miscroscopic amorphous globules which become slightly compressed upon lithification. Another agent might have precipitated the humic acids in the form of streaks. These humates are probably the so-called kerogen bodies.

Other acids, besides the humic were probably precipitated and formed some of the mineral matter in the oil shale deposits. The sulphur which was originally in the plant material in all probability was combined with iron, and formed the pyrite globules and specks found in many of the shales.

As for the diversity of oil shales seen, one may say that the conditions which affect the growth of a peat deposit would affect the growth of an oil shale deposit as well. In addition, however, several other conditions and factors should be considered. The differences in peat are due to such causes as climate, which influences the growth of the peat-forming flora and the water level, the amount of sediment deposited in a season, and the type of flora forming the peat bed. Similarly, we may say that the difference in the clays laid down in past geological ages, were largely due to climate, which influenced the amount of flora growing around the open water area of the ancient swamps; the change in water level causing a difference in time which the fragment took in falling to the bottom therefore causing a difference in the amount of decay. The amount of sediment carried down into this open water region would certainly cause a difference in the type of clay and in the amount of organic matter buried. Of course this condition would probably be a seasonal or climatic variation. The type of flora growing around the open water area would naturally give a different type of material falling into it and cause not only a difference in the amount of decay but also a difference in the appearance of the oil shale. Another factor to be considered is the kind of water present in the swamp—the action of salt water might have been totally different in the preservation of the vegetable debris than the fresh water, and also it would carry different animal life in it, producing a shale of the type found in Bulgaria. Still anoth-

er factor should be taken into account, namely, the type of rock surrounding the swamp. If this rock is sandstone, the shale would probably contain a high percentage of grit, giving a high ash content; and if of shale, it would probably be free from grit; it is also possible that in some places peat and lignite beds were near by to furnish a great amount of organic residue and humic acids.

The varieties of oil shale may therefore be due to the proportion and type of organic and mineral matter, and the proportion of the humates, which were especially precipitated from humic acids by bacteria. The percentage of these materials in an oil shale would of course vary with conditions which affected the origin of the clay deposit. Since a great combination of conditions might have occurred when the clay was forming it is reasonable to expect a variety of oil shale to be found, not only differing in appearance but in content as well. Besides the conditions in the formation of the deposit, changes occurred which caused slight disturbances in most of the clastic material deposited yet not drastic enough to destroy the delicate structure of some of the buried plant materials. What caused the lithification of the deposits without changing much of the contents of the shale is not known, but here again we might be able to turn to our deep peat deposits.

In conclusion it might then be said that it was a swamp which furnished most of the material for the clay deposits which were later compressed into shale deposits, and in all probability the same process is going on now where the conditions are in such combinations as occurred in previous geologic ages.

MICHIGAN MUCK FARMERS' ASSOCIATION MEETING

The Annual Meeting of the Michigan Muck Farmers Association was held February 4th to 6th, 1925, at East Lansing. An excellent program including many papers of vital interest to owners and operators of muck land was presented at the several sessions of the Convention. The following are a few of the ones of especial interest:

"Some Observations on Muck Farming in Europe"
Dr. M. M. McCool, Soils Department, M. A. C.

"The Drainage of Muck Lands"
Prof. H. H. Musselman, Agricultural Engineering Department, M. A. C.

"What Fertilizer and How Much"
Dr. Paul M. Harmer, Soils Department, M. A. C.

"Mint Farming in England"
R. F. Stroud, Mentha, Michigan.

"The Mint Flea Beetle as an Economic Factor in Mint Farming in Southwestern Michigan"
Prof. L. W. Gentner, Entomology Department, M. A. C.

"Truck Crop Varieties and Seed Production"
Prof. George Starr, Horticultural Dept. M. A. C.

"Control of Onion Maggot and Other Insect Pests"
Prof. R. H. Pettit, Entomology Dept., M. A. C.

"Results of Fertilization of Truck Crops on Michigan Mucks, 1924"
Dr. Paul M. Harmer, M. A. C.

"Recent Progress in the Control of Celery Yellows"
Dr. G. H. Coons, Botany Department, M. A. C.

During the convention a banquet was held, practically all the food being prepared from the products of muck soil. The menu was:

Cream of Celery Soup

Celery | Mustard Pickles

Roast Beef, Brown Gravy

Mashed Potatoes

Vegetable Salad

Creamed Carrots | Fried Parsnips

Potato Bread | Corn Meal Muffins

Huckleberry Pie | Beechnut Mints

Coffee

One of the significant actions taken at this meeting was the adoption of the following resolution:

Whereas, the training received by the students enrolled in the Short Course at Michigan Agricultural College has proven of inestimable value to these students in many lines of work, and

Whereas, the course, as now given, does not give opportunity for instruction along the lines of vegetable gardening,

Be it resolved, by the Michigan Muck Farmers' Association, assembled in their seventh annual convention, February 4 to 6, 1925, that the inclusion of such a course, covering the subject of vegetable gardening, in the field on mineral and on muck soil, and in the greenhouse, would be justified in the light of the intensive agricultural development in the state and highly beneficial to the truck farmers living therein.

And be it further resolved, that a copy of these resolutions be forwarded to the President of the College and to the Dean of Agriculture.

Signed:

Lester Allen, Alma
W. E. Sutherland, Seney
Harry Nelis, Holland

Committee on Resolutions

Per,

Paul M. Harmer,

Secy. Mich. Muck Farmers' Association

Such action is abundant proof of the increasing realization of the importance of muck farming. The establishment of courses in our agricultural colleges for giving thorough training to students in the handling of muck soils, best methods of fertilization, the control of insects and diseases and other similar problems is the surest way to bring about a proper appreciation of their value. It is hoped that the M. A. C. can accede to the request of the Association.

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PAST PRESIDENTS
OF THE AMERICAN PEAT SOCIETY

Dr. Joseph Hyde Pratt
State Geologist of North Carolina,
Chapel Hill, N. C.

Dr. Eugene Haanel,
Director Department of Mines,
Ottawa, Ontario, Canada.

Professor Peter Christiansen,
Professor of Metallurgy, School of Mines, University of Minnesota,
Minneapolis, Minn.

Professor A. C. Whitson,
Professor of Soils,
In Charge Agricultural Experiment Station,
Madison, Wis.

Dr. Frederick V. Coville,
U. S. Department of Agriculture,
Washington, D. C.

John N. Hoff,
2 Rector St.,
New York, N. Y.

L. B. Arnold,
Duluth, Minn.

Professor Homer C. Thompson,
In Charge Department of Vegetable Gardening
Cornell University,
Ithaca, N. Y.

Myron W. Robinson,
New York, N. Y.

J. H. Beattie,
U. S. Department of Agriculture,
Washington, D. C.

Manuscripts sent for consideration by the editor should be registered. Written discussions of papers are invited. Authors wishing reprints of articles are requested to correspond with the editor. Advertising rates will be furnished upon application to the secretary.

Journal of the
American Peat Society

Vol. XIX JANUARY, 1926 No. 1

PLANS FOR THE JOURNAL

We request the indulgence of our members, subscribers, and our exchange publications for the non-appearance of the Journal during the latter part of 1925. We have now completed a reorganization plan for the publication of the paper and from this time on it will appear regularly every quarter. It will be conducted along the same general lines but an effort will be made to include more articles, illustrations and other material of greater interest to practical muck farmers. The help of all persons interested in the development of muck and peat is requested in collecting worth while information on the subject. If you have some especially interesting illustrations of the many special methods and equipment used in handling muck soils let the editorial board have it for examination.

An examination of the eighteen volumes of the Journal of the American Peat Society reveals the fact that they contain an immense amount of practical and scientific information on the utilization of peat, for both industrial and agricultural purposes. In the future it can easly be made of greater service than it has been in the past.

Through a plan adopted by the Executive Committee it is now possible for non-members of the Society who belong to regularly organized muck farmers and other agricultural organizations interested in the handling of muck soils to secure the Journal for the nominal sum of $1.00 per annum. The only requirement

being that at least ten subscriptions be sent in by each organization and that these be transmitted by the Sec'y of the local or state society.

A BIBLIOGRAPHY OF AMERICAN LITERATURE ON PEAT AND MUCK

It is a pleasure to announce that the preparation of the bibliography of American literature dealing with peat and muck, a piece of work which has been in progress for several years, is now nearing completion and should be available for distribution within the next month or two. Distribution will be made, to all members of the Society, Journal subscribers and exchange publications.

This work has been done under the direction of the officers of the Society by a trained librarian and represents a careful search of American literature for articles on all phases of peat and muck utilization. An idea of the scope of the work may be gained from the statement that the references cover some seventy pages of typewritten material. Owing to the heavy cost of printing a report of this character it is our plan to mimeograph it. It would be a fine thing if some of our members and supporters could see their way clear to make a contribution toward the expense of this work. What do you think of the idea of devoting one issue of the Journal to the printing of the bibliography? The cost of the printing is the only thing that stands in the way. This bibliography undoubtedly contains references to experimental work or to ideas which might save you thousands of dollars in the handling of your peat fuel or muck soil problem.

MR. KNAP RETIRES AS SECY.-TREAS. OF THE SOCIETY

Owing to continued bad health Mr. Charles Knap who has served the Society as Secretary-Treasurer since 1918 has been obliged to relinquish the work. His resignation was presented at the Nineteenth Annual Convention held in Michigan, September 8 to 12, 1925, but action was not taken at that time in the hope that conditions would develop which would make it possible for Mr. Knap to continue the work. Decision was made at the meeting of the Executive Committee held in Washington on February 1926 to accept Mr. Knap's resignation as it appeared that there was no hope that he could continue the work. The secretary-treasurer elected at this meeting was instructed to forward the following letter to Mr. Knap as a token of appreciation from the Society for the most excellent services rendered over a long period of time.

Washington, D. C., Feb. 2, 1926.

Mr. Charles Knap,
2 Rector Street, New York City.

Dear Mr. Knap:

The Executive Committee of our Society learns with the deepest regret that you are unable to continue as Secy.-Treas. of the organization and it is our hope that your health will improve until you have regained your former vigor.

We wish to express profound appreciation, both as individuals and as officers of the Society for the long, meritorious service rendered the organization. I am happy to inform you that it is the unanimous recommendation of the Executive Committee that you be made an honorary member of our organization.

Very sincerely yours,

American Peat Society, Inc.
JAMES H. BEATTIE, *Secy.-Treas.*

MEETING OF EXECUTIVE COMMITTEE AT WASHINGTON FEBRUARY 2nd

A meeting of the Executive Committee of the Society was held in Washington, D. C. on February 2, 1926. Several matters of vital importance to the organization received attention.

The resignation of Mr. Charles Knap as Secy.-Treas. presented at the Michigan meeting in September, 1925 was accepted with regret. A letter of appreciation for the long and faithful service of Mr. Knap to the Society was prepared and forwarded. Mr. J. H. Beattie was appointed to serve as Secy.-Treas. until the next Annual Meeting.

Arrangements were perfected for the financing of the Journal and publication ordered resumed beginning with the January, 1926 issue. It was decided to include more material of interest to muck farmers in the columns of the Journal and to offer subscriptions at $1.00 per annum to members of local or state agricultural organizations interested in muck and peat. It was made conditional that not less than ten subscriptions be received from each organization taking advantage of this offer and that they be sent in by the proper officer of the organization.

Plans for the next Annual Meeting were discussed and it was decided that it be held at Cleveland, Ohio during the week of September 12th in connection with the Annual Meeting of the Vegetable Growers Association of America. Plans for an exhibit of muck products to be held in connection with the Convention were discussed and it was decided to hold an educational exhibit with prizes to be given for the best offering in each class. Details of this exhibit are to be found in another part of this Journal. It was also decided to hold an exhibit of commercial peat products and supplies, a plan for this to be worked out by the officers of both organizations.

THE 1925 CONVENTION AT EAST LANSING

In reality the 1925 Convention of the Society was held at several points in Michigan. The first two days were spent at East Lansing and nearby points while the other three days were devoted to a most interesting tour of some of the principal muck areas of the southwestern portion of the state.

Michigan occupies a foremost place in peat and muck areas and in the amount of attention these are receiving at the hands of the State Agricultural Colleges and Experiment Stations. The Society was very fortunate in having an opportunity to visit the state. The reception accorded the organization was wonderful and the thanks of all who were so fortunate as to enjoy the hospitality of the Michigan State College and Michigan muck farmers is of the most sincere character.

The sessions of the Convention were joint meetings with the Michigan Muck Farmers Association. The latter Society is the largest organization of this character in the United States. The first session was on Tuesday morning, September 8, this being followed by afternoon and evening sessions. The evening of the 8th was devoted to the Annual Business Meeting and the President's address. This is printed elsewhere in this issue. The second day was devoted to a program during the forenoon with a tour of the campus, a marsh breaking demonstration, a marl digging demonstration and an inspection of experimental plots of the Michigan State College on Chandler's Marsh in the afternoon.

Many excellent papers were presented at the sessions. Some of these appear in this Journal and others will be printed from time to time. No attempt will be made here to review these papers for the editors feel that they are not qualified to select those of most importance.

One of the very enjoyable features of the stay in East Lansing was the entertainment at luncheon on Tuesday the 8th by the College in the famous pinetum. The tables were spread between the rows of 30 year old white pines and those who were so fortunate as to be there will long remember the occasion.

On Thursday September 10th several machine loads started

on a most enjoyable tour of some of the more important muck areas of the southern portion of the state. This trip was made in machines provided by the College to whom the thanks of those present are due for this courtesy. During the first day a visit was made to the well-known Gunn Marsh, one of the largest muck areas in that section. Regardless of the extremely unfavorable season an excellent crop of onions was being harvested on this area. Later in the day a visit was made to the famous Todd place at Mentha and an enjoyable period spent inspecting the new mint still, representing the most advanced practice for the production of mint oil. The field practices followed on this farm are the last word in muck soil management. Among other crops cultivated on the farm alfalfa occupies a prominent place. Mention is made of this as alfalfa is seldom mentioned as a muck crop.

An inspection of the well known Kalamazoo celery area ended the day.

On the second day a visit was made to the celery fertilizer plots on the muck area around Decatur. This work is being carried on under the charge of Prof. Harmer who explained the work in detail. The photograph on page 13 was made while the inspection was in progress. The muck farm of Mr. Dexter Brigham was the next place visited and proved to be an excellent example of successful muck soil management. Many other points of interest were visited and all who were privileged to take the trip enjoyed a most unusual experience.

THE 1926 CONVENTION, CLEVELAND, OHIO

The adoption of plans for the 1926 meeting of the Society was one of the most important actions of the Executive Committee at its meeting held in Washington on February 2nd. It was decided to hold the meeting at Cleveland, Ohio, September 14th to 17th in conjunction with the Annual Meeting of the Vegetable Growers Association of America. Many reasons led to this action. Both organizations are keenly interested in the use of muck soils for the production of vegetable crops. The simultaneous meetings will make it possible for many to attend both conventions at no additional expense.

Headquarters for the Meetings will be in the Winton Hotel where most excellent accommodations are available at moderate cost. There is an abundance of exhibit space and plenty of assembly rooms for all sessions of both organizations. It is the hope of the Executive Committee that a comprehensive exhibit can be staged of muck soil products and equipment and materials needed in the handling of peat soils and products. It is planned to divide this exhibit into two distinct parts, the first to be of a competitive nature consisting of muck soil crops; the other to be a commercial exhibit of implements, fertilizers, or other materials of this nature. For the first class it is hoped that substantial prizes can be offered while a nominal space charge will be made for the commercial exhibit.

An earnest request is made for the cooperation of all interested persons in making both exhibits a success. As a tentative outline of the competitive exhibit it has been suggested that the following classes be included.

Class 1. Best peck and dozen specimens of muck grown carrots.

Class 2. Best six heads of muck grown Danish or Hollander type cabbage.

Class. 3. Best crate muck grown head lettuce.

Class 4. Best peck and dozen specimens muck grown yellow globe onions.

Class 5. Best peck and dozen specimens muck grown potatoes (white skinned).

Class 6. Best ten ears muck grown field corn.

Class 7. Best ten ears muck grown sweet corn.

Class 8. Best peck and dozen specimens muck grown parsnips.

Class 9. Best peck and dozen specimens muck grown beets.

Class 10. Best sweepstake exhibit of muck crops. Units of each to be of same size as those in different classes. This exhibit to be made as a unit. No individual lots to be entered in more than one class.

All products to be grown by the person or firm making the exhibit, and to be accompanied by a statement showing the methods used in their production, and the area from which the specimens were taken. These reports to be considered by the judges in making the awards.

The Officers of the Society would like to know how this idea appeals to the members. It is an opportune time to start plans for such an exhibit as growers can make plantings with the definite purpose of making an exhibit. How many will enter? Who will offer prizes as an incentive to exhibitors? Now is the time to make definite plans for this important feature. Let the Secretary have your views at once. The details of the exhibit will be announced in the April number of the Journal.

STUDIES IN MICHIGAN MUCK SOILS

By Paul M. Harmer, Soils Dept., Michigan State College

I. Distribution, Composition and Classificatioin of the Muck Soils of Michigan.

For fifty years the muck soils of Michigan have had a national reputation for their productivity. With this reputation established largely because of the fine yields of celery obtained from a relatively few muck areas in the vicinity of Kalamazoo, it has long been a popular opinion outside of the state, and with many residents within, that all Michigan muck soils are inexhaustibly fertile and productive. The fact that heavy applications of manure were necessary for the production of good yields of celery apparently was overlooked and the soil was given credit for a store of fertility which it did not contain.

Investigation has shown that all of the muck soils of the state are not of the same type as those of the celery producing areas at Kalamazoo. Further it has been shown that the methods suitable for crop production on one type of muck are not necessarily applicable to other types. These facts, coupled with their wide distribution, creates a need for a practical classification of these muck areas, from an agricultural standpoint.

Distribution of Muck. Michigan is unique in its distribution of muck land. In a majority of the states containing muck soil, that muck is confined to some portion of the state, either due to climatic or geological differences. In Michigan, on the other hand, the muck land is quite uniformly distributed over the entire state, usually in relatively small areas, ranging from three or four acres up to three or four hundred acres or more in extent in the southern part of the state. In the northern portion and in a few localities in the southern part, considerably larger areas are to be found. For the most part, however, the distribution is so uniform that a considerable proportion of the farms have a muck area within their bounds.

Another unique feature of the mucks of the State is the relative distribution of the high-lime and low-lime areas. Unlike the situa-

tion in many states where the low-lime mucks are confined to some portion in which muck land is found, the low-lime mucks in Michigan are intermingled with the high-lime mucks throughout the state. In the southern part of the state the former are generally found in smaller areas than the latter and often in close proximity to the high-lime mucks. Thus within forty rods of the high-lime muck area on which the potato plats reported in a following paper were located, and within the same farm, lies a four-acre low-lime, intensely acid huckleberry bog from which the farmer generally realized a net profit of $15.00 to $25.00 per acre per year from the sale of huckleberries. Again within a mile of the most highly developed muck area in the state is to be found an area of over 100 acres, reclaimed by farmers who would have duplicated the successes of their neighbors, but who found their fields intensely sour, with many barren spots on which onions and other truck crops refused to grow and on which celery plants died within a few days after having been transplanted to the field.

Relation of Native Vegetation to Lime Content. As a result of the investigations which have been conducted, it has been found possible to some extent to identify the low-lime muck areas of the state by the native vegetation. There are no doubt, exceptions, due in part to abnormal conditions, such as burning over, or change in water level, with a consequent change in vegetation, but to a considerable extent, as outlined below, the native vegetation is indicative of the lime content of the muck soil.

Composition of the Muck. Analyses of several muck soils of different origins (Table 1) as well as of one fertile clay loam and one unproductive sand shows the mucks to exceed the mineral soils in content of organic matter and nitrogen, and generally lime. In phosphoric acid content the muck soils compare with the unproductive sand, while the potash content (results not shown) of the mucks is far lower even than that of the sand.

Contrary to popular opinion in Michigan which holds that all muck soils will respond to a lime application, chemical analyses and field tests show that 90 per cent of the muck soils of southern Michigan contain sufficient lime. Because of complete failures made in farming the low-lime muck, and the intermingling of the two types, as stated above, special study has been given in

the liming, fertilization and management of these different types of muck soil.

In our tests for acidity, we have found no method which will reliably indicate the need of a lime application on muck land. Of the several tests, none has proven as satisfactory or convenient as the Soiltex test developed by Professor Spurway of this College. A neutral, slightly acid or moderately acid reaction indicates that the muck does not need lime for any crop. A very strongly acid reaction (Soiltex color deep orange to brick red) indicates the need of lime for all crops, while a strongly acid reaction leaves the question in doubt, to be best solved in a liming test in the field.

Classification of Michigan Muck Soils. The muck soils of the state may be grouped according to lime content, and fertilizer requirement for general crop production as follows:

TABLE I

Composition of Nineteen Michigan Soils (Seventeen Muck Soils and Two Mineral Soils) ([1]), expressed in pounds, per acre, taken to a depth of eight inches. ([2])

Soil No.	Location County	Original vegetation	Organic matter	Mineral matter	Insoluble ash (3) (ash)	Soluble ash	Degree of acidity (solitex)	Lime (CaO)	Phosphoric acid (P_2O_5)	Nitrogen
1	Ingham Co. No. 2	Moss and huckleberry	391,800	208,200	187,200	21,000	Very strong	2,460	522	11,994
2	Kalamazoo	Moss and huckleberry	519,600	80,400	67,800	12,600	Very strong	2,460	798	-----
3	Ottawa No. 2	Moss and huckleberry	465,000	135,000	107,400	27,600	Very strong	9,600	1548	13,152
4	Missaukee No. 2	Sedge	544,800	55,200	37,800	17,400	Very strong	6,400	1400	13,344
5	Berrien No. 1	Sedge	449,400	150,600	93,600	57,000	Strong	22,200	1956	16,464
6	Berrien No. 2	Sedge	480,600	119,400	54,000	65,400	Medium	19,200	1704	18,918
7	Ingham No. 1	Sedge	460,800	139,200	58,200	81,000	Very slight	25,400	2016	17,994
8	Gratiot	Tamarack	486,600	113,400	35,400	78,000	Not acid	38,200	2316	12,510
9	Ottawa No. 1	Tamarack	482,400	117,600	45,000	72,600	Very slight	36,000	3354	17,346
10	Calhoun	Tamarack	500,400	99,600	30,600	69,000	Very slight	36,600	1878	18,342
11	Lapeer No. 1	White cedar, tamarack and ash	409,200	190,800	83,400	107,400	Not acid	40,800	2664	16,530
12	Lapeer No. 2	White cedar, tamarack and ash	489,000	111,000	24,600	86,400	Not acid	47,400	----	-----
13	Huron	White cedar, tamarack and ash	510,600	89,400	22,200	67,200	Not acid	40,800	1476	12,510
14	Eaton	Mixed, tamarack predominating	454,800	145,200	81,600	63,600	Very slight	26,400	1578	16,146
15	Missaukee	Mixed growth	442,200	157,800	85,800	72,000	Medium	20,600	2382	11,616
16	Washtenaw	Mixed growth	451,800	148,200	64,800	83,400	Slight	24,200	2322	18,690
17	Van Buren	Ash and elm	399,600	200,400	107,400	93,000	Very slight	40,200	----	15,084
18	Tuscola, clay loam		95,000	1,905,000	------	-----	Slight	21,200	3470	4,400
19	Cass, sandy loam		32,800	1,967,200	------	-----	Strong	8,400	1640	1,120

(1) From Special Bulletin 136, "The Muck Soils of Michigan—Their Management for the Production of General Crops."

(2) Calculation on the basis of 600,000 pounds as the weight per acre for the surface 8-inch layer of muck soil, and of 2,000,000 pounds for that of upland (mineral) soil.

(3) Determined by digestion with aqua regia.

1. High-lime group. (Degree of Acidity. pH. [1] 5¼ or greater.)
   a. Native vegetation. A native growth of black ash and elm, maple, white cedar, large tamarack, willow or alder is a certain indication of sweet muck in southern Michigan, while a sedge growth also generally indicates a high-lime muck soil. In central and northern Michigan the ash, elm and maple ordinarily are not found growing on the muck, while the sedge is frequently found on muck which is not high in lime content.
   b. Fertilizer requirement.
      (1.) Newly reclaimed muck—no immediate fertilizer requirement. If several crops of marsh hay have been removed before the land is first reclaimed, fertilization may be required for the first crop.
         x. Very shallow deposits.[2] The muck disappears within a few years after the underlying material has been turned up by the plow.
         y. Deep, medium and shallow deposits. After one or more years, this group falls under (2) or (3).
      (2.) Old muck-potash only required. After several years this type of muck will develop also a phosphoric acid requirement.
         x Deep and medium deposits only.
      (3.) Old muck—phosphoric acid and potash required.
         x. Shallow and very shallow deposits.
         y. Deep and medium deposits.

2. Transitional group. (Degree of Acidity—p H 4¼ to 5¼.)
   a. Native vegetation. The vegetative growth generally resembles that of the low-lime group but is usually not so abundant and is often mixed with that native to high-lime muck.

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[1] The pH is a numerical expression of the hydrogen ion concentration, or degree of acidity, of the soil. A soil which is neutral, that is one which is neither acid nor alkaline, has a pH of 7, while some of the very acid mucks have a pH as low as 3.6.

[2] In the above classification, the terms very shallow, shallow, medium and deep muck are applied to deposits of newly reclaimed acreas having depths of 1-16 inches, 17-32 inches, 33-48 inches and 49 or more inches respectively. After the muck has undergone settling for the first few years after drainage, these terms would be more correctly applied to deposits having depths of 1-12 inches, 13-24 inches, 25-36 inches and 37 or more inches respectively.

b. Fertilizer requirement. Phosphoric acid and potash needed.

c. Lime requirement. The need of lime for this group varies both with the muck and with the crop to be grown. Thus potatoes and carrots will produce good crops on muck which is too sour for sugar beets, while onions will yield well on muck which requires lime for good yields of celery and lettuce. Lime requirement may decrease after drainage and settling.

x. Shallow and very shallow deposits.
Lime need generally disappears as decomposition and settling increases.

y. Deep and medium mucks.

3. Low-lime group (Degree of Acidity—pH less than 4¼).

a. Native vegetation. Previous to reclamation the vegetation is generally an abundant growth of huckleberries, leather leaf, and other shrubs, with sphagnum moss, cranberries or dwarf tamarack; or a barren area, sometimes entirely devoid of vegetation. In central and northern Michigan the sedge muck is frequently low-lime, and the black spruce becomes associated with the dwarf tamarack.

b. Fertilizer and lime requirement.
Lime, nitrogen, phosphoric acid and potash needed.
Deep and medium deposits only.

SUMMARY

Investigation of the muck soils of Michigan has shown that:

1. The muck lands are widely distributed over the state, generally in relatively small areas.

2. In composition the muck areas vary markedly, especially in lime content, the low-lime mucks being intermingled with the high lime mucks but generally readily identified by the fairly well defined vegetative growth native to the low-lime group.

3. The muck soils may be grouped according to their fertilizer and lime requirements for general agriculture as follows:

1. High-lime group (Degree of Acidity—pH 5¼ or more).
   - (a) New muck—No fertilizer requirement for from 1 to several years.
   - (b) Old muck—potash only required.
   - (c) Old muck—potash and phosphoric acid required.

2. Transitional group (Degree of Acidity—pH range from 4¼ to (5¼). The need of lime for this group varies both with the muck and with the crop to be grown. Potash and phosphate required.

3. Low-lime group (Degree of Acidity—pH less than 4¼). Lime, potash, phosphate and nitrogen required.

MUCK AND PEAT SOILS FOR POTATO PRODUCTION

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Paper Read at Nineteenth Annual Meeting of Society East Lansing, Mich., Sept. 8-12, 1925

During the past ten years, the production of certified seed potatoes in the United States has developed from a few thousand to several million bushels annually. Much is being said and written about the various factors influencing the quality of such seed, chief among which are disease, climate and storage. Production has centered mainly in the provinces of Ontario, Prince Edward Island and New Brunswick, Canada and in Maine, Vermont, New York, Michigan, Wisconsin, Minnesota, North Dakota and Nebraska.

Altho numerous and distinct soil types are being used for seed and table potato production in each of these regions, apparently very little study has been given to the influence of soil type on either yield or quality of seed and table potatoes. It is safe to say that most soils used for potato production are of lighter, better aerated type than the majority of soils used for corn, small grain and forage production. This is true, of course, for the reason that most of the soils of the cooler latitudes where the bulk of the commercial crop is grown, are of glacial formation. It is generally known that light soils produce brighter skinned potatoes of higher starch content than do our heavier soils. The excellent table quality of Maine and Long Island potatoes is now well established. A part of this reputation is no doubt due to the parent soil, much of it also to the inherent quality of the Green Mountain variety grown. In other regions, success in production has been measured mainly in terms of yield, more or less irrespective of either eating quality or value of the crop for seed purposes.

Relatively few potatoes have been grown on either muck or peat soils in this country up to the present time. Two main reasons may be ascribed: first, the limited area of tillable organic

soils available for potatoes rather than strictly muck crops; second, the rather common prejudices against muck-grown potatoes for either seed or table purposes.

Muck Soil Production Increasing

A survey of muck soil production in New York was conducted last year by the Department of Vegetable Gardening at Cornell University in cooperation with the State Department of Agriculture and the County Farm Bureaus. Fifteen of the sixteen counties having important muck areas were included. A summary of the acreage of each crop planted in 1923 and 1924 is shown in table I. These figures are approximate and subject to revision.

TABLE I.

Acreage of Muck Planted to Various Crops in 15 Counties of New York in 1923 and 1924.

Crop	Acreage 1923	Acreage 1924	% of total acerage 1924
Lettuce	4952	4548	32
Onions	3655	4064	29
Celery	3018	3769	27
Carrots	655	1043	7
Potatoes	234	533	4
Squash	41	128	1
Total	12,555	14,085	100

A 12 per cent increase in 1924 acreage over 1923 is shown in the above table. This increase is in response to the generally increased consumption demands for the principal muck crops. About 4 per cent of the total muck acreage surveyed was planted to potatoes in 1924. Most of this was in the Elba district of Orleans and Genesee counties and in Wayne County, much of the crop being planted to the Cobbler variety for seed purposes. The one important muck area not included in the above survey—Orange County—is devoted mainly to onions and potatoes. Here again the potatoes are mainly Cobblers grown for the early table stock market. Our attention is, therefore, drawn to the comparative value of muck and upland-grown potatoes for both table and seed purposes.

Muck Versus Upland Soil For Potatoes

Very little experimental study has been made to determine the value of muck and peat soils for this crop. Witte, a Swedish investigator, experimented with potatoes on moor (peat), sandy and clay soils and found that, contrary to common opinion, tubers from moor soils have good keeping quality. His results also indicated that seed produced on peat soil yielded better than seed from sandy soil when planted on sandy soil. However, the difference was not so marked when these two types of seed were planted back on peat soil. Thousands of acres of peat soil are now being put into condition for potato and seed potato production in Minnesota. Tolaas, chief inspector of seed potatoes in Minnesota, reports the recent development of large tracts of peat soil for seed potato production in that state. To quote, he says "We have two or three peat areas in the state that are undergoing development at the present time, and from my observations will say that the crops produced on these soils are of excellent quality. There has been a certain prejudice against potatoes grown on peat soil for seed purposes, which . . . . seems to be entirely unfounded. We have one grower who is having his potatoes inspected for certification and who is growing potatoes on peat for the third consecutive year. The seed used this year was grown on peat last year and the seed used in 1923 was produced on peat in 1922. The yields produced are about double the yields obtained by the farmers on the best mineral soils. The keeping and eating qualities of the potatoes are excellent." Notably large yields are now being harvested from the famous "tule" lands in the Stockton district of California, much of the success here being due to proper moisture control by subirrigation.

With the idea of investigating the comparative adaptation of muck and upland soils for seed potato production, the Department of Vegetable Gardening of the New York State College of Agriculture began a series of experiments in the spring of 1923. Highly selected disease-free certified strains of the Green Mountain, and Cobbler types were chosen for seed stock. In order to avoid both seasonal and cultural influences and so far as possible to make soil type the only variable factor, test plots were located on farms where both soil types were available. One-eighth acre plots

of 1,200 hills each were planted on each soil type. The Green Mountain variety was planted on muck and stony silt loam at Marion and the Irish Cobbler on peat and light sandy loam at Kirkville, New York. Soon after the blossom period, 144 hills were carefully dug from each plot and data on both tops and tubers taken. Counts of all tubers large enough to be identified were made at this time to avoid the usual losses from decomposition or absorption which follow later in the season. Both total and marketable yields were recorded after maturity and random seed samples reserved for test the following year. Data on yield, foliage, and tuber-set are given in table II.

TABLE II

Results in 1923 from Planting Two Varieties on Two Soil Types
(Foliage and tuber-set data taken at end of blossom period)

Factor	Irish Cobbler Kirkville, N. Y.		Green Mountain Marion, N. Y.	
	Peat	Sandy loam	Muck	Silt loam
Maximum height plant in inches	18.8	22.1	37.3	22.7
Number of stalks per hill	4.43	4.56	4.40	3.80
Number of tubers per plant	21.43	28.5	30.5	22.7
Average weight per tuber in oz.	.55	.48	1.23	.49
Total yield per acre in bushels	54.7	185.5	374.0	189.0
Yield of primes (per cent)	57.7	87.4	86.6	87.5

The above data indicate a fairly positive correlation between number of stalks per hill and number of tubers per plant. It is also apparent that tuber-set was higher in the lighter or better aerated soils than in the heavier types. The yields are significant only in-so far as they may have a bearing on the value of the crop as used for seed.

Soon after the four seed samples were placed in storage at Ithaca, the Department of Home Economics cooperated in a cooking test to determine their comparative eating qualities. Contrary to the common prejudice against the eating quality of muck-grown potatoes, both the peat-grown Irish Cobblers and the muck-grown Green Mountains revealed a whiter flesh and a mealier product when boiled than did the same varieties grown on the upland soils. Samples of seed from each of the four soil types were

tested both at Ithaca and at Riverhead, New York, in 1924. The results are briefly summarized in table III.

TABLE III

Results of 1924 Test of Seed Produced in 1923 on Four Soil Types

Seed grown 1923 on	Variety	Test at Riverhead 1924 No. tubers per hill	Test at Riverhead 1924 Total yield per acre bus.	Test at Ithaca 1924 No. tubers per hill	Test at Ithaca 1924 Total yield per acre bus.
Peat	Irish Cobbler	5.14	141.6	10.07	376.0
Sandy Loam	Irish Cobbler	4.42	121.4	8.08	345.0
Silt Loam	Green Mt.	4.35	113.2	8.30	456.2
Muck	Green Mt.	4.73	120.5	8.64	474.0

The Irish Cobbler plots from the peat-grown seed consistently came up a few days earlier than those from the sandy loam-grown seed. However, this advantage was apparently overcome at about midseason. No difference in time of come-up or in time of maturity was noted in the other plots. Here as in the previous year, tuber-set was with one slight exception closely correlated with yield in both varieties and in both soil types. The wide average differences in tuber-set and yield between the test at Ithaca and that at Riverhead is explained from the fact that seasonal conditions at Ithaca were extremely favorable while the test at Riverhead suffered considerably from drought. It is very significant that altho all four lots of seed were grown under uniform and carefully controlled conditions both at Ithaca and Riverhead, both tuber-set and yield were consistently higher in the crop from the peat-muck grown seed than in the crop from seed grown the previous year on the heavier soils. The results are especially interesting from the fact that the yield of the Irish Cobbler seed crop of the previous year was larger from the heavier soil type. Here, therefore, is some indication that soil type not only greatly influences tuber-set and yield in the seed crop, but also that this influence is effective in the crop resulting from it the following year.

To further test the factor of soil type, a different strain of equally high grade seed of the Green Mountain variety was again planted on the same soil plots in the spring of 1924. No plantings of the Irish Cobbler variety were made. Data on tuber-set

were taken at harvest time rather than at midseason. Unfortunately no foliage measurements of the Green Mountain plots were made this year. Data on the 1924 seed crop as grown on the two soil types are recorded in Table IV.

TABLE IV

Results in 1924 from Planting Green Mountain Variety on Two Soil Types. (Data on tuber-set taken at harvest time)

	Green Mountain Muck	Green Mountain Silt loam
Maximum height of plant in inches	not taken	not taken
Number of stalks per hill	not taken	not taken
Number of tubers per plant	10.33	10.20
Total yield per acre (bushels)	354.4	238.4
Yield of primes (per cent)	76.6	52.4

This year as in 1923, tuber-set was higher in the muck soil. Furthermore, it will be noted that, as usual, tuber-set and yield showed a positive correlation. Random samples of each lot of seed are being tested this year and results will be available this fall.

Summary and Conclusions

Soil type as one of several important ecological factors has for some time been known to influence the potato crop in many and diverse ways. Such influences have included yield, time and maturity, eating quality, tuber-set, and shape of tuber. Just how and to what extent these factors are inherent in certain soil types and whether these effects are potent in the following crop are problems which might profitably be investigated. The experimental work outlined and briefly summarized in this paper has in the main substantiated the results obtained by others in that light or well aerated soils other things being equal, are productive of (1) larger yields, (2) a larger number of tubers per hill, and (3) a potato of better eating quality, than are the heavier soils. Furthermore, the author's recent experiments have indicated that the influence of soil type, per se in respect to vigor and tuber-set in the seed crop may be transmitted to the following crop. Further work is necessary to verify these conclusions and to determine whether other factors affected by soil type may be similarily transmitted.

ECONOMIC FACTORS INVOLVED IN THE PRODUCTION AND MARKETING OF MUCK CROPS

By Dr. L. C. Corbett, U. S. Dept. of Agriculture

Paper Read at Seventeenth Annual Meeting of Society Washington, D. C. Dec. 6, 1923

The soil areas of this country suitable for agricultural practices may be grouped into three general categories—the prairie, the forest, and the reclamation lands. The prairie lands offer less resistance to agricultural operation of an extensive scale than any of the other land areas. In fact, it invites extensive production by a sparse population which must seek distant markets for its surplus products. The world's granaries are, for the most part, developed in the plains or prairie regions in those parts of the world adapted to the production of cereals. Cereal production expands most rapidly under such environment during the developmental period of the country.

Along with the expansion of grain production goes the exploitation of timber in the timbered areas within the same political division in which cereal development is taking place. As the forests are cleared of their timber a more productive type of agriculture must follow, because land covered with stumps cannot compete in the world's market in the production of cereal grains, with lands free from stumps, where, with improved machinery, one man is master of one-hundred-sixty or more acres. If, on the other hand, as in the early days of the settlement of this country, the trees are removed for the sole purpose of making the land available for food crop, the problem is different; but we, in this country, have long since passed this stage of land development. The areas from which the forests were removed in an early day to make room for cereal production gave way to grain production in the prairie regions, as soon as transportation and invention furnished facilities for their development.

The agricultural utilization of cut-over lands has for many years been an important consideration in many sections of this country, and until the stumps are removed by man or by the elements,

the question of the economic utilization of such acres for agricultural purposes will continue to be an important problem. So long as the prairie regions continue to produce abundantly and the area available is sufficient to provide the needs of the nation and a reasonable surplus for reserve and export, there will continue to be a disinclination to make the necessary investment in the clearing of cut-over land to bring it under agricultural operation.

Reclamation areas, whether the reclamation takes the form of irrigation or drainage, naturally belong to a land classification requiring even higher capitalization than cut-over lands to bring them into production. In other words, the prairie lands require practically no investment to make them available for agricultural purposes; cut-over lands requires sufficient investment to remove stumps and timber and make the lands available for agricultural purposes. Reclamation lands, whether through irrigation or drainage, require an investment sufficient to provide water, on the one hand, and to remove the water on the other. Which of these types of lands will come into agricultural utilization first will depend upon the economic conditions obtaining in the region at the particular time. If the population is adequately supplied with the standard food products from the land requiring the lowest expense for preparation and the operation and transportation costs are not prohibitive, such areas will naturally continue to dominate the production of staple crops handled on an extensive basis. Lands which require a larger investment per unit area to prepare them for agricultural operations must necessarily yield a larger return than that ordinarily produced by the staple crops, if such lands are to be devoted to these crops, otherwise new or different crops which do not compete in the markets with the products of the extensive production areas must be developed.

In the handling of reclaimed land a still higher investment is required than that needed in the handling of cut-over lands. with the exception of a few special areas where reclamation can be accomplished at low cost, or on the other hand, where the cost of removing stumps is inordinately high.

It has always been a difficult problem to develop a satisfactory agricultural production for the reclamation projects where irrigation has been undertaken. With the exception of those areas

where special crops, such as citrus fruits or deciduous fruits can be handled on a large scale, it has been a very great problem to make reclaimed lands remunerative. The ordinary agricultural crops, such as corn, small grains, and hay, cannot be made to carry the over-head involved in the operation of such lands, particularly where they are in competition with low cost lands existing in relative abundance, situated nearer the markets, and which produce a fairly large return per acre. In other words, the reclamation of lands requiring irrigation or drainage is an undertaking which should have most careful and thorough consideration and should be undertaken only in those localities and under those conditions which make it possible to grow crops of such an intensive character as to insure an adequate return for the large investment involved.

As the density of the population of a country increases and the demands for food supplies of various kinds increase, there will be a gradual and legitimate demand for the utilization of the agricultural lands carrying a high over-head cost of operation and demanding a large outlay for their preparation and development. It is obvious, however, that such activities should be undertaken only after a careful analysis has been made of all the factors involved in the development and maintenance of such areas and a sound agricultural and economic basis is assured. Until such periods in the development of the country occur, it is wiser without doubt to allow natural conditions to obtain.

It would appear as though a wise providence had provided extensive areas which can, when economic conditions justify, be brought under intensive cultivation through the application of water; as well as extensive areas which are annually improving in character so long as the water is not removed from them and they are not subject to agricultural depletion. Neither drainage areas or irrigation areas can be economically operated on an extensive basis. Such lands pay a satisfactory return only when devoted to high-power crops under intensive cultivation. In this connection, however, we must not lose sight of the fact that the nation's requirements for such crops can be adequately met by a relatively small area.

A Special Consideration of the Organic Soil Problem

Within the continental area of the United States there exists a very considerable number of more or less extensive soil areas which may be classed as organic in their nature and which require reclamation for their agricultural utilization. As has been said, as long as these lands remain undisturbed and undrained they are not losing any of their potential agricultural value. They constitute a great resource which wisdom would dictate should be held in reserve until the population of the country has become sufficiently dense and economic conditions sufficiently acute to warrant bringing them under agricultural operation. They constitute a great agricultural reserve of immense potential value to the nation. As soon, however, as the population in any particular territory has become sufficiently dense to justify bringing such lands under the plow, there should be no hesitation to undertake reclamation work on a basis commensurate with the demand. With lands capable of reclamation at reasonable cost, within a reasonable distance of centers of large population, it would be folly to let such lands lie idle and depend upon distant areas for the production of such organic soil crops as onions, celery, lettuce, etc., which could be offered to that market in a superior condition and possibly at greater profit to the producer than from the distant field of production.

If I have made myself clear, organic soils should be utilized when they are to be found within the zone covered by the economical truck haul or rail haul to large centers of population. Lands of this character outside of such areas might, in general, better be left as grazing lands than to be brought into competition with other agricultural lands with which they cannot successfully compete in the production of low cost commodities, such as cereal grains and hay.

Experience has indicated that it is, up to the present time, unwise to enter into the extensive reclamation of organic land areas and to undertake to devote them exclusively to intensive agriculture. Practically all of the enterprises which have been launched upon this basis have failed. The great successes in the handling of organic soils have followed from a combination of enterprises involving the production of the staple cereal and forage crops upon upland, along with a relatively small acreage of intensive crop production on reclaimed alluvial soils. Several of

the extensive reclamation projects which, a few years ago, were undertaken and were developed on the basis of special crops, have almost entirely returned to the basis of a combination of staple agricultural enterprises on a rather extensive upland area and a relatively small intensive operation on reclaimed organic soil. There are, of course, exceptions to this general rule. There are small reclaimed areas devoted exclusively to intensive crop operations which are, on the average, highly successful. In general, however, organic soils are not located under an environment which permit of a long succession of crops so that, if one is a failure, the losses sustained may be recouped by devoting the land to still another crop during the same growing season. Most of these lands and most of the crops adapted to them are of such a nature that only a single crop can be harvested during a growing season. There are exceptions to this also, where small areas of land are located near enough large markets to be devoted to market garden purposes. In general, however, the utilization of organic soils must be on the basis of intensive field crops, such as make up the bulk of the so-called truck crop production.

The organic soils of this country constitute one of its greatest agricultural assets. A policy of conservation reclamation of these soils based on the present and prospective future needs of the country should be inaugurated. The exploitation of these soil areas for other than legitimate agricultural and other utilization purposes is a crime against posterity and should not be permitted.

The great reserves of plant food stored up through the ages in these rich alluvial deposits are thoroughly appreciated by those who have developed them to a high state of cultivation; but they realize that the land area required to supply the nation's needs of the crops which can be profitably produced on such soils is relatively small in proportion to the whole acreage required to supply the nation's needs for food materials. The legitimate utilization of these lands, however, is just as important as their appropriate conservation.

THE MINT FLEA-BEETLE AS AN ECONOMIC FACTOR IN MINT FARMING AND MEASURES FOR ITS CONTROL

By Professor L. G. Gentner, Entomolgy Dept.
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Paper Presented at Nineteenth Annual Meeting of Society at East Lansing, Michigan, Sept. 8-12, 1925

In the light of recent investigation, the mint flea-beetle* appears to have been the cause of more or less serious injury to cultivated mint for at least the past eight or ten years. It may be found in Michigan in practically all localities where mint is grown, and has increased in numbers to such an extent that it now seems to be one of the principal factors in limiting the length of time during which mint may be "kept in the ground" profitably. Very little was known in regard to this pest until the season of 1924, and its injury to mint was usually laid to other causes.

The mint flea-beetle is a small insect, about one-twelfth of an inch in length, light brownish-yellow in color, with reddish-brown head and black eyes. The hind legs are very long and the hind thighs much enlarged, enabling it to jump readily.

The adult beetles appear during July and feed upon the mint leaves, riddling them with holes, and causing them to turn brown and to drop off. After a feeding period of three or four weeks, mating takes place and egg-laying begins. The eggs are about one-fortieth of an inch in length, oval in shape and yellowish-orange in color. They are laid singly, either on the surface of the soil, or just below. The beetles have never been seen in flight, but they gradually migrate into the uninfested fields, continuing egg-laying until severe cold weather sets in. The following spring, about the latter part of May, the eggs hatch, and the slender, whitish larvae or "worms" begin to feed on the smaller mint roots. They may either kill the plants entirely, or stunt them so badly that they fail to produce much oil. The larvae become full-grown, by the mid-

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**Longitarus menthaphagus* Gentner MS.

dle of June or later, at which time they are about one-fifth of an inch in length. They leave the mint roots at this time and form small cells in the soil, in which they pupate, or pass through the resting stage. Two or three weeks later the adult beetles emerge from these cells to start the life cycle over again.

The study of the habits of the mint flea-beetle during the season of 1924 has suggested two ways of combatting this pest,—the poisoning of the mint along the margins of new mint fields to kill the adult beetles as they migrate from infested fields; and the poisoning of the stubble and crop remnants in infested fields, as soon as the mint has been cut for distilling, in order to kill the beetles before they lay many eggs. In normal years, very few eggs are laid before the mint is cut.

Control measures during the past season were confined mostly to the use of dusts. This was owing to the apparent repellant effect of liquid-sprayed plants and to the better penetration and more even coverage by the dusts. Because of the serious losses caused by this pest, and because of its resistance of arsenicals, heavy dosages of poison were used. It is planned to carry on further work with liquid sprays and with smaller amount of poison.

For successful control, the materials used should be without repellant effects, so that the beetles will feed and be killed; the dusts should be light and fluffy enough to insure good distribution on the plants; and they should stick reasonably well.

The poisons tried were paris-green, calcium-arsenate, lead-arsenate and calcium-fluosilicate. Paris-green gave the quickest kill, but it had the disadvantage of being rather heavy and not covering well, and of costing considerably more than other poisons used. Calcium-arsenate was found to be the most practical and economical poison to use. It was light enough in weight to dust well, adhered to the foliage, and gave nearly as quick a kill as paris-green. Lead-arsenate, even when used in large quantity, did not give satisfactory control, but seemed to have a repellant effect. Calcium-fluosilicate, used undiluted in the form purchased, (about 22 per cent), gave good control, but was rather slow in its action. It had the advantage, however, of covering well, and of adhering to the foliage very well, and new mint was successfully protected against invading beetles by this material alone.

The materials used as carriers of the poisons were finely

ground gypsum, hydrated-lime, talc and flour. The gypsum was non-repellant to the beetles, but was too heavy to dust well. The hydrated lime, while light enough had a repellant effect, and few beetles were killed on mint dusted with this material as a carrier. Talc proved very satisfactory and flour served very well, although the latter was heavier than talc, and ordinarily would cost more.

The poisons were applied at the rate of ten and twenty pounds in a hundred pounds of dust, the heavier doses giving a somewhat quicker kill. Ten to twenty percent of calcium-arsenate with talc, and ten to twenty percent of calcium arsenate with equal amounts of calcium-fluosilicate and talc, were found to be the most satisfactory dusts tried. These dusts should cost the grower around six to seven dollars per hundred pounds.

As soon as the adult beetles appear in the old fields, the new mint toward these areas should be protected by thoroughly dusting the margins of the new field at the rate of thirty or forty pounds of the dust per acre. Three or four applications per season may be necessary. Egg-laying should be prevented as much as possible in infested fields by dusting the stubble and remnants immediately after the mint has been cut for distilling, using about twenty-five pounds of the dust per acre. In a normal season, few eggs are laid before the mint is cut. If these practices are carefully followed, the cost of control should be considerably lower each succeeding year, as the infestation is reduced. Special attention should be given to those fields from which roots are to be pulled for new plantings, and care should be taken to shake as much of the soil from the roots as possible to avoid carrying eggs to the new fields. The larger types of hand-dusters serve very well for small acreages, but for large plantings it is necessary to use a traction or power-duster.

Nicotine dusts appeared to be of little value, even when they contained as high as four percent nicotine. Practically one hundred per cent of the beetles dropped to the ground, and lay apparently dead shortly after the dust had been applied, but within three hours, ninety percent or more had completely recovered and these were as active as ever.

There were usually never many dead beetles found on the ground at any one time as a species of small ant and a small ground

beetle were quite active in feeding upon these dead bodies. The outer skeletons and wingcovers could often be found in numbers at the entrances to the burrows of the ants, where they had been placed after the soft parts had been eaten.

ACCOMPLISHMENTS AND NEEDS OF THE PEAT INDUSTRY

President's Address at the Nienteenth Annual Meeting, East Lansing, Mich., Sept. 8-12, 1925

It is well to pause at times and recall the purposes of such an organization as ours. To summarize, in the briefest way, the purposes and aim of the Society we might simply say that it is maintained for the purpose of encouraging investigational work on peat and peat soil problems, and in the dissemination of the information secured from this work to persons interested in the industry. It seems fitting at this time to review the accomplishments of the organization and to study plans for the future, seeking to ascertain whereby the Society can be of greater service to investigators and practical land owners and others for it is a fact that the worth of any organization of this character is measured by the kind of service it renders. If we cannot give worth while assistance there can be no reasonable expectation that adequate support will be accorded.

I am not especially familiar with the early history of this Society, but some of you probably helped with its organization and have supported it through the 18 years of its history. I am sure that the thought which promoted its formation was the magnitude of these great natural resources and the need of definite information on the subject. Nothing more natural can be imagined than the desire to exchange ideas. This fundamental consideration lies behind the development of most of our scientific organizations. Progress has been made during the two decades the American Peat Society has been in existence but all persons familiar with the subject feel that today as never before there exists a great demand for accurate, fundamental information on the subject in the form of the results of experimental or more properly speaking research work, to serve as the basis of recommendations for the utilization of peat and peat soils for agricultural and industrial purposes.

The Journal is the first of the important facilities made use of by the Society in the dissemination of information on peat and

peat soils. It is one of the few periodicals devoted to such special subjects as peat and while its circulation is not large, it goes to practically every country in the world and has exchange relations with a large number of technical publications, some of them being the acknowledged leaders in their respective fields. The files of the Journal are in many of the leading libraries of the Old and New World, and the volumes are constantly referred to by workers and others interested in the subject. It is felt that the Journal of the Society is one of its activities which deserves full and complete support on the part of the members, for after all the permanent value of the papers and proceedings of the meetings of the society to many of the members who cannot attend the sessions lies in their being made of permanent record by publication in the Journal. Any person owning peat land or interested in its handling or utilization for agricultural or industrial purposes, cannot afford to be without the numbers of the Journal.

The advisory and Research Committee of the Society was formed at the Washington, D. C., Convention in December, 1923 for the purpose of rendering advice and other service to members of the Society relative to special peat problems. This Committee is made up of many of the leading authorities in America on peat and the service rendered is of high worth and would cost, if privately engaged, large sums. It has functioned very satisfactorily and it is hoped that its activities can be broadened and the membership still farher augmented unil it will be possible to give every inquiry all detailed information which may be avilable in either the published or the unpublished form. In connection with its activities the committee is preparing a complete bibliography of American peat literature. This will be available within the next few months and it is hoped that we can secure means to print it in the Journal. I believe this will be a milestone in our study of the subject for we all know the difficulty now experienced in securing even a partial biblography of the subject. It is hoped that the work can be continued until all foreign work of consequence is reviewed and included. More will be said about this subject at the business session of the convention.

Our Board of Councillors may be referred to as our Board of Directors and we look to them to provide the means with which to carry on the work of the organization. Our deepest thanks are

due the broad visioned men who have contributed to the needs of the Society during its history. I am especially grateful to those who have supported it so liberally during the past year. It is hoped that the Board for the coming year can be enlarged to include at least ten men and plans for this will be discussed at the Annual Business meeting.

While all these things are of the utmost importance in furthering the aims and purposes of the Society I suspect that the things which count most with us are the friendships formed and maintained through common interest in a great subject, and our association together upon the occasion of our meetings. These things cannot be measured by any scale within our reach, but to me they mean more than any other feature of the organization.

A brief review of some of the more important accomplishments in the solution of leading peat problems should be helpful in arriving at a decision as to the best line of endeavor for the future. In the statements of a few minutes ago relative to the immensity of the problem and the small amount of information now available when compared with remaining, unsolved problems, it was not the intention or the purpose to belittle the epochal work of many investigators and to minimize the importance of commercial practices now in for the utilization of peat for cropping, fuel, and other purposes. We have but to turn to the work of such men as Davis, Haanel, Alway, Coville, White, Manns, Whitson, Thompson and others to secure abundant proof that peat problems however perplexing, can be solved provided they are attacked from the right direction. It is the desire, however, to impress you with the great need for fundamental investigational work to throw more light on the problems which so richly deserve the attention of the best research men. Mention will be made in the following remarks of some of the important accomplishments in peat problems, but only a few illustrative cases can be mentioned. I have not picked these because they are of more importance than others, but because they illustrate accomplishments in a wide variety of fields embracing most of the important uses of peat.

The work of Davis, Soper, Osborn, and Dachnowski on the subject of the formation and distribution of peat should properly be regarded as of the utmost importance. Along with these men should be mentioned a large number of state and other workers

who cooperated in the securing of the information which made such results possible. While, of the greatest worth the studies made by these investigators is only a beginning, and there is still need for much careful survey and research work.

In the field of peat fuel we have the splendid work of the Canadian Department of Mines, directed by Mr. Haanel who is to discuss the subject at this meeting. The activities of our own Bureau of Mines, directed by Dr. David White, are no less noteworthy and have served the useful purpose of distinctly indicating the possibilities and limitations of peat as fuel in the United States.

I regret that we have so little information on the use of peat and peat products for industrial purposes. The work of Soper and Osborn shows that we have peat moss deposits in this country which perhaps would yield a product fully equal to that imported from the old world. As far as I am aware the development of the business in this country is in its infancy and more attention should be devoted to the problem.

I believe that it is generally agreed that the greatest possibilities for peat in the United States and Canada at this time is for agricultural purposes. In this classification is grouped the use of various peat materials as an ingredient of fertilizer, for stock food, and similar purposes.

The development of peat resources for the production of crops has been very remarkable. It is only within recent years that the American land owner has begun to appreciate the possibilities of our so called muck soils for crop production. The term muck is I believe an unfortunate one as the same designation is applied to many other materials, leading to great confusion. Moreover there is no distinct line of demarcation between peat and its decomposition product muck and it is therefore impossible to know just what is referred to through the use of the two names. Personally I am very much in favor of dropping the term muck as applied to peat soils and use what I consider a far better designation, peat soils, to differentiate the material referred to from peat itself. Along the same line of reasoning we would have peat moss, peat litter, and other products referring to peat in different stages of decomposition. I believe the society should discuss the advisability of adopting this nomenclature.

Peat soil of suitable character for the production of potatoes, onions, cabbage, celery, lettuce, beets, cauliflower, sweet corn, peppermint, sugar beets, corn and many other field and truck crops, is to be found in large areas in many parts of the United States, Canada, and other parts of the World. It is a well known fact that few other soil types will produce the heavy yields of high grade crops to which peat is adapted that are characteristic of this type of soil. It has been spoken of as the vegetable soil par excellence. While it was formerly believed that peat was adapted only to a very restricted list of crops it is now known that with proper management a very large list of vegetable and field crops can be grown on peat with very satisfactory results. The United States has millions of acres of land which is of a more or less peaty character. Canada has far greater areas. It is impossible to state how much of this has potential possibilities for crop production as a comparatively small proportion is now developed and in use. Certainly we have enough peat of *potential* high value to satisfy all normal demands for cropping purposes for a long time.

Outstanding results in the securing of information regarding the use of peat deposits for agricultural purposes have come from the work of Alway, Whitson, Musbach, Manns, Thompson, and many others. Here in your own state you have in progress a line of investigational work on peat soils which has yielded extremely valuable results and which promises still greater benefits. It is a wonderful testimony to the wisdom of the authorities of this state who have made such a line of investigational work possible. Cultural, fertilizer, insect and disease and kindred problems have and are receiving adequate attention. Could other states having important muck soil problems attack these on the same scale, rapid progress would be made in securing the fundamental data which must be available before we will be in a position to intelligently handle this great problem. The work being carried on in this state will be reviewed in a number of papers to be presented at this Convention.

In an endeavor to learn the developments of the past year in the development of our Peat resources a number of inquiries were addressed to persons in several states where the problem is attracting attention. In the replies received, this thought seemed to me to be outstanding. There is an increasing realization of

the economic value of peat soil and it is being used more and more for crop production. Florida with her enormous areas of peat finds the material of extremely great value for vegetable and other crops, Minnesota reports an increasing use of peat soils for crop production. Important fertilizer, lime, water table and other investigational work is in progress in that state. New York has just completed a five year rotation, fertilizer study on peat soil, now has a comprehensive demonstrations project with lettuce and onions. A survey of vegetable acreage in muck soils is being made. Rhode Island, Delaware, and other states are devoting attention to peat soil project with valuable results being obtained.

When we consider the magnitude of the peat problem, we are forced to the conclusion that there is a very great call for the Society to render every possible assistance to the established research institutions and to more actively conduct independent or cooperative research work. Perhaps I am building my hopes too high but it really seems possible for the Society to actively cooperate with our State and other investigational institutions in the carrying on of research work. The Society is seeking no particular credit for itself being interested only in the securing of additional evidence to assist in the economic utilization of our peats whether for industrial or agricultural purposes and would be perfectly content to have the results of such in investigational work published as bulletins or the institutions cooperating in the conducting of the work. Later summarizing or reprinting in the Journal of the Society would make the information available to all our members and the large number of investigators throughout the World who refer to the Journal from time to time.

We already have a well organized Advisory and Research Committee and it should be a simple matter for us to enter an agreement of understanding with institutions in states having large peat areas under which coordinated investigational work could be undertaken.

We have some definite evidence indicating the possibilities of peat and its decomposition products for the growing of greenhouse crops. Additional data is needed on this, however, and such activities could be undertaken without great expense to either cooperator. Another problem of vital interest to many is the possible worth of peat in its various forms for use on surrounding up-

land or as a dressing for soils for truck and other intensive crops. We know through experience that it is valuable on many soils for the securing of good stands of certain crops such as small seeded vegetables where baking of the soil prevents the seedlings from breaking through. What are the limitations and the advantages of peat for dressing soils for intensive crops? Here again we have a fine field for some nice work which would be of great practical value.

Peat is an important subject, the deposits of the World representing a great and fortunately a largely undeveloped economic asset. While American coal and oil deposits are so large and so widely distributed that the utilization of the material for fuel may be at least a problem of the future unless it be in regions remote from coal and oil deposits and where peat can be harvested and dried at low cost the value of peat for other industrial and agricultural purposes such as a fertilizer ingredient, in stock foods, as packing material, for the production of greenhouse and other crops and especially in the field for the growing of flax, hemp, sugar beets, potatoes, peppermint, cabbage, onions, celery, carrots, cauliflower and other vegetable and field crops is of the greatest importance. I need not remind you that well developed and improved peat soils yield crops of those plants to which it is suited that can be equalled with difficulty on other types of land. Never was there greater need for such an organization as this. It is my hope that you gentlemen will formulate and put into effect plans for the strengthening and upbuilding of this Society.

SOME RECENT PUBLICATIONS OF INTEREST TO MEMBERS OF THE SOCIETY

Technical Bulletin No. 71 of the Agricultural Experiment Station, Michigan State College, East Lansing, Michigan, entitled "Growth of Lettuce as Influenced by Reaction of Culture Medium" by John W. Crist is of much interest as it summarizes experimental work which in the language of the author says: "These experiments have demonstrated conclusively that at least under some conditions lettuce is an acid tolerant plant. Ordinary and even unusually high soil acidity, per se, is not detrimental to its growth. In fact, it does best in a medium of growth that is distinctly acid in reaction, when the necessary nutrient materials are present in proper quantities and proportions. The experimental evidence that has been presented leads to the belief that the very general and more or less promiscuous use of lime on, lettuce soils is not unnecessary but probably harmful."

Special Bulletin No. 136 of the Agricultural Experiment Station, Michigan State College, East Lansing, Michigan, entitled "The Muck Soils of Michigan" by M. M. McCool and Paul M. Harmer has just been issued and is a most valuable contribution to muck literature. The bulletin deals with Michigan muck soils but much of the information applies with equal force to other districts having peat soils of similar character. It contains discussions on the origin of muck soil, the history of muck land development, reclamation and drainage, preparation of soil for cropping and summarizes numerous field tests on high lime, low lime and intermediate types of muck. It is the feeling of the Editorial Board that the research work summarized in the bulletin is perhaps the most valuable portion of the publication. The fertilizer practices recommended as a result of this experimental work forcefully illustrate the great practical value of work of this character to the practical muck farmer. While without assurance as to the available supply of the bulletin it is presumed that copies may be obtained upon application to the College.

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Address communications for committee to J. H. Beattie, McLean, Virginia.

SCOPE AND PURPOSE OF SOCIETY

The American Peat Society was organized at the national exposition at Norfolk, Va., on October 23, 1907, and was incorporated in 1912. It is an organization devoted to research and to the dissemination of information concerning the origin, metamorphosis, geographic distribution, physical and chemical properties, and uses of peat and muck.

Through its Advisory and Research Committee, consisting of botanists, geologists, chemists, bacteriologists, and engineers, the society will answer inquiries from members relating to the use of their deposits. There is no charge for general service.

NATURE AND USES OF PEAT AND MUCK

Peat and muck are residues resulting from the arrested decomposition of leaves, twigs, roots, trunks of trees, shrubs, mosses, and other vegetation in areas covered or saturated with water. They may be identified as the dark-colored soils found in bogs and swamps and in other low places. The commercial uses of peat and muck are varied. In the United States they are utilized chiefly as crop soils, as soil conditioners, and as ingredients of fertilizers. In some of the countries of Europe peat is used for fuel and is the basis for small manufacturing industries. Gas, charcoal, coke, and some by-products are produced in small quantities. Peat moss, marsh grass, and fibrous peat are employed in the manufacture of litter, packing material and rugs, and selected varieties of peat moss have been used to make surgical dressings.

ECONOMIC ASPECTS OF PEAT

The United States contains over 12,000 square miles of undrained peat and muck land. The average deposit, if used for industrial purposes, will yield 200 tons per acre-foot. It is estimated that the deposits would be capable of yielding about 14 billion short tons of air-dried peat. Peat and muck areas are distributed throughout the Great Lake, Pacific Coast, and Atlantic Coast States. Peat and muck in Canada cover 37,000 square miles. According to published statistics, European countries annually consume about 50 million tons of peat fuel.

MEMBERSHIP

Present membership of the American Peat Society consists largely of agriculturists, engineers, and peat and muck land owners and producers. Persons interested in agriculture, in soil fertilization, in the chemical and bacteriological aspects of vegetable matter, and in the production of fuel or generation of power, may join. Applications should be addressed to the secretary. Membership and subscription to the Journal cost $5.00 a year.

CONVENTIONS AND PUBLICATIONS

Meetings of the Society are held annually in important cities throughout the peat regions. Papers are presented relating to the subjects enumerated. A quarterly journal, containing the proceedings of the Society, papers concerning all phases of peat, muck, and allied subjects and news of the industry, is published and sent to members. The scope of the papers is very broad, including the location of deposits, drainage and reclamation problems, methods of cultivation, fertilizer requirements, crop adaptation, cultural practice, physical and chemical characteristics, engineering practice, and production methods. One of the principal objects of the Society is the exposition of extravagant claims made by promoters.

APPLICATION FOR MEMBERSHIP

IN THE

American Peat Society.

(Date)

Mr. J. H. Beattie, *Secretary-Treasurer*,
American Peat Society,
McLean, Va.

Dear Sir:

Application is hereby made for membership in the American Peat Society, Check in the sum of $5.00 for subscription to the Journal of the American Peat Society during the first year is inclosed. It is understood that the payment of this sum will admit me to the society and entitle me to all the privileges granted to members by the constitution. This is prompted by my interest in the science and utilization of peat and muck and the welfare of the society.

Yours very truly,

Signature.

(Address)

CONTENTS

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Manuscripts sent for consideration by the editor should be registered. Written discussions of papers are invited. Authors wishing reprints of articles are requested to correspond with the editor. Advertising rates will be furnished upon application to the secretary.

Journal of the
American Peat Society

Vol. XIX APRIL AND JULY, 1926 Nos. 2 and 3

THE 1926 MEETING AT CLEVELAND, OHIO, SEPTEMBER 13-18.

It will be recalled that the Executive Committee decided to hold the 1926 meeting of the society at Cleveland, Ohio, jointly with the Vegetable Growers' Association of America. The program as far as worked out as the Journal goes to press is presented herewith. Some important papers are to be added and a final edition of the combined program will be issued just before the meeting.

PROGRAM.

MONDAY, SEPTEMBER 13, 1926

8:00 P. M.*—Meeting of Executive Board, Vegetable Growers' Association. Winton Hotel.

Meeting of Executive Committee, American Peat Society. Winton Hotel.

Meeting Exhibits Committee, Vegetable Growers' Association. Winton Hotel.

Meeting of Executive Committee Trades Section, Vegetable Growers' Association. Winton Hotel.

Meeting Local Committee on Arrangements for Convention. Winton Hotel.

*All meetings and appointments of the convention by Eastern Standard Time.

TUESDAY, SEPTEMBER 14, 1926

Morning

10:00 A. M. —Opening Session, Jointly with American Peat Society. Winton Hotel.

Call to Order and Address of Welcome by Mr. John Hoag, chairman local committee on arrangements, presiding.

Response and Address by Mr. Walter J. Marion, President, Vegetable Growers' Association.

Address, Dr. Paul M. Harmer, East Lansing, Mich., President, American Peat Society.

Report of Secretary, Vegetable Growers' Association.

Report of Secretary, American Peat Society.

Appointment of Committees and Announcements.

12:30 P. M. —Adjournment for lunch.

TUESDAY, SEPTEMBER 14, 1926

Afternoon

2:00 P. M. —Sectional Meetings.

Outdoor Section, Vegetable Growers

Discussion of methods of handling early vegetable plants. Led by Mr. C. H. Nissley of New Jersey.

Bean Aphis and its control, Mr. H. L. Gui, Ohio Experiment Station, Wooster, Ohio.

Insects that are causing heavy losses to the vegetable grower, Mr. N. F. Howard, Bureau of Entomology, U. S. D. A.

Tomato Streak, Mr. A. G. Newhall, Ohio Experiment Station, Wooster, Ohio.

GREENHOUSE SECTION, VEGETABLE GROWERS

Special seed strains and their production, Mr. W. T. Tapley, Philadelphia, Pa., formerly State College, Pa.

Tomato mosaics, Dr. W. G. Stover, Ohio State University, Columbus, Ohio.

Watering greenhouse crops, Louis F. Miller, Toledo, Ohio, Past President of Vegetable Growers' Association.

Marketing greenhouse crops, Mr. Walter J. Marion, Circleville, Ohio, President Vegetable Growers' Assocation.

AMERICAN PEAT SOCIETY

Prevention of wind injury to crops on peat soils, Dr. Paul M. Harmer, East Lansing, Mich.

Drainage and water control on peat soils, Mr. W. C. Steenburg, South Bend, Indiana.

The Commercial uses of peat, by Mr. W. G. Newbury, Chicago, Ill.

Potato production on peat soils, Mr. Paul N. Davis, Albert Lea, Minn.

Development of peat lands for vegetable production, Prof. H. C. Thompson, Ithaca, N. Y.

Problems in onion production on peat lands, Mr. E. H. Faulkner, Lodi, Ohio.

TRADESMEN'S SECTION

MR. HARRY J. BALTZ, *Chairman*

Advertising value of field demonstrations, Mr. Frank Held, Columbus, Ohio.

Moral obligation of the manufacturer and salesman, Mr. Harry J. Baltz, Columbus, Ohio.

Methods of stageing trades exhibits at conventions, Mr. Philip Foley, Forest Park, Ill.

Evening

8:00 p. m. —General Session, Open to the Public.

Music, Community Singing, Ohio delegation leading.

Address of welcome, Hon. John D. Marshall, Mayor of Cleveland.

Address, vegetable growing as a business enterprise, Hon. R. W. Dunlap, Assistant Secretary of Agriculture, Washington, D. C.

Pictures, How Plants Grow, presented by Kuttroff, Pickhardt & Co., Inc., New York City.

Reception to members and visitors.

WEDNESDAY, SEPTEMBER 15, 1926

Morning

9:00 a. m. —General Session.

Are we getting the most out of our fertilizers? Mr. J. W. White, Professor of Soil Technology, State College, Pennsylvania.

Lime as a factor in the production of truck crops, Prof. T. C. Johnson, Director, Virginia Truck Experiment Station, Norfolk, Va.

The preparation of peat composts and their use as substitutes for manure, Dr. T. F. Manns, Professor of Plant Pathology and Soil Bacteriology, University of Delaware, Newark, Del.

General discussion of soil problems.

Afternoon

2:00 p. m. —General Session.

Round table discussion on the grading and marketing of vegetables. (Leaders to be announced.)

3:30 P. M. —Sectional Meetings.

Continuation of the programs of the various sections from Tuesday afternoon. Business meeting of the various sections.

EVENING

Annual Banquet, Winton Hotel.

(Time to be announced.)

Entertainment features of the banquet in charge of members of the Tradesmen's Section.

THURSDAY, SEPTEMBER 16, 1926

MORNING

4:00 A. M. —Trip to Cleveland Produce Market, arrangements in charge of local committee.

9:00 A. M. —General Session Vegetable Growers' Association. Annual business meeting and election of officers.

10:00 A. M. —Symposium on disease and insect problems of vegetable growers, leader, Dr. H. C. Young, Ohio Experiment Station, Wooster, Ohio. A general discussion of practical questions relative to the control of diseases and insects on vegetable crops.

11:30 A. M. —Leave hotel for Brooklyn Heights where a special lunch will be served by the local committee.

Luncheon followed by special talk and demonstration on vegetable diseases by Mr. A. G. Newhall.

Field demonstrations of tractors and other equipment on exhibit at convention by members of Tradesmen's Section.

EVENING

8:00 P. M. —Theatre party, under direction of local committee.

FRIDAY, SEPTEMBER 17, 1926

Morning

9:00 A. M. —General Session.

What the standardization of vegetable varieties and strains means to the grower, Prof. A. H. MacLennan, Guelph, Ontario, Canada.

Progress report on vegetable variety standardization, leader, Prof. Paul Work, Ithaca, N. Y.

10:30 A. M. —Final business session and adjournment of all meetings of the convention.

11:30 A. M. —Leave hotel for tours.

Afternoon

Tour, members of Vegetable Growers' Association to Rocky River and Olmstead Falls sections to visit several modern greenhouse plants and truck farms.

Tour, members American Peat Society to Warren, Ohio, and vicinity to visit a number of peat deposits and truck farms located on peat lands.

Special Features

Special entertainment is being arranged for the ladies who attend the convention, including a trip to one of the country clubs and a tour of Cleveland's splendid department stores with tea at the Lindner Company.

CLEVELAND HOTELS

Hotel Winton, Headquarters, Meetings and Exhibits.

Hotel Cleveland, Hotel Statler and Hollenden Hotel; also a large number of smaller hotels within reasonable distance of the Winton.

Here is a list of the rooms available in the Winton Hotel for

housing the members of the Vegetable Growers' Association and friends during the week of September 13, 1926:

Ten group rooms accommodating eight men each at $2.00 a day per man.

Fifty-five single rooms,	5	at $2.50 a day.
	10	at $3.00 a day.
	5	at $4.00 a day.
	35	at $5.00 a day.
One hundred double rooms		at $5.00 a day.
Fifty double rooms		at $5.50 a day.
One hundred double rooms		at $6.00 a day.
Fifty double rooms		at $7.00 a day.

The above if filled to capacity will house 735 persons, all accommodations provided with bath and every modern convenience. The management of the hotel has guaranteed to provide the above and further guarantees that there will be no increase in prices and that reservations will be held in accordance with the letter of confirmation that will be sent all those who make their reservations in ample time for confirmation to reach them. All those making reservations should state whether they will come by train or automobile, as the Winton management will include taxicab ticket without charge to those who are coming by rail.

The Winton hotel maintains a large and splendid coffee shop on the main floor just off the lobby. Special vegetable dishes will be featured during the convention and the management will welcome suggestions in advance of the convention. There is also a splendid dining room on the main floor of the hotel which is famed for its excellent food and refined service at reasonable prices. An added attraction of the Winton dining room and lobby during the dinner hour is the splendid music furnished by a select orchestra led by the famous radio violinist, Louie Ritz. Anyone who enjoys good music will find this feature of entertainment very attractive.

There are a number of good restaurants within reasonable distance from the Winton Hotel, but the management of the Winton will provide extra help and facilities to care for a large number of persons during the convention.

The Winton Garage, under separate management, but conducted in close cooperation with the Winton Hotel, is located just across

Bolivar Road from the rear of the hotel, with a direct entrance to the lobby of the hotel. Safety and courtesy are the characteristics of the Winton Garage. No oils or gasoline are kept in the garage, but may be had at a separate oil station adjacent. Your car stands on a clean concrete floor, your windshield is cleaned and your radiator filled without extra charge or obligation. Other service may be had at reasonable rates.

J. H. Beattie,
Acting Secretary-Treasurer.

CULTURAL STUDIES ON A MUCK AREA IN OCEANA COUNTY, MICHIGAN[1]

An Investigation of the Need of Cultivation, Heavy Rolling and Plowing of Muck Land

By H. I. Sippy and Paul M. Harmer,
Soils Department, Michigan State College

In the many years of agricultural management of mineral soils, certain cultural practices have become thoroughly established. It is generally conceded among farmers that these practices are correct, and that their ommission or improper carrying out will result in a decreased yield of the crop being grown. With the relatively recent reclamatoin of muck land, what is more natural than the adaptation of the mineral soil practices on the muck, without any consideration of the fact that the type of soil might indeed be a determining factor in the benefit, or lack of benefit, secured from any given cultural treatment.

Little experimental work along the line of investigation of the different cultural methods on muck land has been reported. Alway (1) has reported results from plowing and heavy rolling treatments carried on in 1918 at the Golden Valley (Minnesota) muck experimental farm, in which he used fourteen different crop combinations, namely, spring rye, spring wheat, oats, barley, field peas, potatoes, rutabagas, rape, alfalfa, sweet clover, brome grass, western rye grass, timothy, red clover and red top, and timothy, alsike and red top. With only three out of the fourteen crops (rutabagas, rape and sweet clover) were better yields secured on the unplowed than on the plowed muck, while with eight of the fourteen, heavy rolling of the plowed muck produced an increased yield over that which was not rolled.

Cultural experiments involving cultivation, plowing and heavy rolling were conducted in 1922 and 1923 on muck land in Oceana county, Michigan. Since different factors have prevented a continuance of this work, the results secured during the two years are presented below.

1A portion of a thesis, "A Study of the Agricultural Reclamation of a Muck Area in Oceana County, Michigan," presented by the senior author, in partial fulfillment of the requirements for the degree of Master of Science, Michigan State College, 1925.

Experimental

The experimental work reported below was carried on on a portion of a muck area of about 3,000 acres in extent, located in eastern Oceana county. The experimental field was located on muck which for the most part exceeded eight feet in depth, and which originally supported a growth of tamarack, with an admixture of black and white ash, elm, and occasionally soft maple and poplar. The field had been burned over quite uniformly in 1918, although there were a few small burn-outs scattered over the area. The depth of burning varied from 9 to 18 inches in depth and to a large extent all weed seeds were destroyed, so that the field was still fairly free from weed growth during the season of 1922. The depth of the water level during the season of 1922 varied from an average of 35 inches to an average of 42 inches in different parts of the five acre field.

The experiments, as laid out in 1922, included three one-acre plots, one each of sunflowers, corn and spring rye. In 1923 oats was substituted for the spring rye, and winter rye, sown in the fall of 1922, added to the group. In the case of the sunflowers, spring rye and winter rye, the effect of preparation of the seed bed by plowing, as compared with disking only, was studied. With oats both fall and spring plowing were compared with preparation of the seed bed by disking only. On the sunflowers an additional study of the effect of different numbers of shallow cultivations as compared with no cultivation was made. On all plots, the seed bed was prepared by a uniform use of the spring tooth and spike tooth harrows, following plowing and one double disking of the plowed portion, or following two double diskings of the unplowed muck. All plots were fertilized broadcast, at the rate of 300 pounds acid phosphate (16 per cent phosphoric acid) and 250 pounds muriate of potash (50 per cent potash) per acre.

Across the strips of plowed and unplowed muck, rolling treatments with the 30-inch concrete roller (weight 700 pounds per foot of length) were made on all crops. As indicated in the tables below, rolling treatments both before and after planting were compared with no rolling.

Sunflowers

Table 1 shows the yields of sunflowers secured from the different treatments. The seed bed was first prepared on April 20. On

May 28 the field was given a thorough harrowing with the spike-tooth drag, and on May 30 planted with Russian sunflowers, drilled in rows 35 inches apart. Cultivations were made on June 30 and July 9, 16 and 23. Plots 6 and 7 were separated from plots 1 to 5 inclusive by a narrow sand bar, the former plots generally appearing slightly more productive than the latter.

It is evident that heavy rolling was of marked benefit to the sunflower crop. One rolling before planting gave as good results as were secured with three rollings but rolling after planting gave better results than rolling before planting. Rolling both before and after planting appeared to have no advantage over rolling after planting. In this connection mention should be made of rolling treatments on sugar beets on muck in Ingham county, in which heavy rolling after planting scattered the seed to such an extent that cultivation was interfered with. On such crops, heavy rolling before planting, followed by light rolling after planting, would avoid seed scattering.

In a comparison of no cultivation with two and four cultivations of the sunflowers, the uncultivated portion of the field gave the highest, and that cultivated four times the lowest yields, both on the unplowed and spring-plowed muck. As explained above, weed growth was quite limited.

A comparison of deep and shallow cultivation of peppermint on muck land in Eaton county in 1923 in which shallow cultivation gave considerably the better results should be mentioned at this point. These results would indicate that cultivation of muck is needed only for the eradication of weeds.

In the comparison of spring plowing vs. no plowing in the preparation of the seed bed for sunflowers, the yield on a majority of the plots was higher on the unplowed than on the spring plowed land. The heavily rolled spring plowed muck produced larger yields than did the unrolled unplowed plots but the average yields on the unplowed plots were higher than on the spring plowed with the same rolling treatment.

Corn

A set of plots identical in every way to the sunflower plots, except that corn, planted May 30, was used as the crop, was also established on this field in 1922. A killing frost on the night of July 3 injured the crop to such an extent that the experiment was discon-

tinued. Later the crop recovered and cultivation was resumed, but severe frost early in September killed the crop. At that time the corn on the unplowed muck ranged from six to eight feet tall, while that on the spring plowed muck was six feet or less in height. If this difference was due to a lesser amount of frost injury on the unplowed than on the spring plowed muck, such difference was not evident immediately after the frost of July 3.

In 1923 both the sunflower and corn plots were re-established as in 1922, except that the crops were interchanged, but numerous severe frosts occurring during the summer destroyed both crops and prevented the drawing of any conclusions.

Oats

In preparation for the cultural experiment with oats, the fall plowing was done on October 1, while the spring plowing and disking were done on May 3. Preparation of the seed bed was carried out as for the sunflowers, the fall plowed and spring plowed strips receiving one and the unplowed strips two double-diskings. The field was then harrowed uniformly. Worthy oats were sown at the rate of 3 bushels per acre and the rolling treatments made on May 5. The results are presented in Table 2.

The most striking result secured from this set of plots was the difference in yields secured from the different plowing treatments. The yields from the spring plowed muck averaged about half those secured from the unplowed muck, with those from the fall plowed muck intermediate.

Little or no increase in yield of oats was secured from heavy rolling of the unplowed muck. On the plowed muck considerable increase was secured when the heavy rolling was done after planting, but little or none when rolled before planting.

Rye

Preparation of the seed bed for spring and winter rye was identical with that for sunflowers, the spring rye being drilled on April 29, 1922, while the winter rye was drilled on October 3. Rosen rye was the winter variety sown. The crops of rye (Table 3) gave results consistent with those secured with the oat crop. Plowing produced considerably lower yields of both crops than were secured from the unplowed muck.

Heavy rolling appeared of little benefit to the spring rye crop when the rolling was done before planting. When rolled after planting, some benefit was secured. Rolling twice during early growth (Plot 10) appeared to decrease the yield. In the case of the winter rye, heavy rolling in the fall either before or after planting appeared of no benefit, but heavy rolling in the spring produced considerable increase in yield.

Conclusions

In a cultural study with three crops, sunflowers, oats, and rye, on a Michigan muck area, the following results were secured:

1. Higher yields were secured by the preparation of the seed bed by disking than by plowing, and higher yields by fall plowing than by spring plowing.
2. Use of the heavy concrete roller produced much greater increases on the plowed than on the unplowed muck land, but on the unrolled unplowed muck the yields of oats and rye were generally higher and of sunflowers lower than on the rolled plowed muck.
3. Heavy rolling gave considerably larger yields when the rolling followed planting than when it preceded it.
4. Results secured with sunflowers and corn indicate that cultivation of muck land should be practiced only for the eradication of weeds.

Literature Cited

1. Alway, F. J., Report of Golden Valley Peat Experimental Fields, 1918 and 1919. Minn. Agr. Exp. Sta. Bul. 194, 116 pp., 1920.

TABLE 1. EFFECT OF CULTIVATION AND HEAVY ROLLING ON YIELD OF SUNFLOWERS

Plot No.	Rolling Treatment	Spring Plowed			Not Plowed			Average of all Cultivated
		No. of times cultivated						
		4	2	None	None	2	4	
		Tons per A.	Tons per A.	Tons per A.	Tons per A.	Tons per A.	Tons per A.	Tons per A.
1	Not rolled	6.0	8.8	12.6	13.7	12.8	12.4	11.1
2	Rolled once before planting	12.9	19.0	15.6	15.5	15.4	14.0	15.4
3	Three times before planting	13.0	14.8	13.5	16.3	15.8	13.0	14.4
4	Once before and once after planting	16.6	14.7	16.7	14.9	16.8	16.1	16.0
5	Once after planting	16.3	17.7	18.5	15.2	14.8	18.0	16.7
6	Not rolled	12.7	15.6	18.0	14.9	15.3	14.1	15.1
7	Once before and once after planting	16.5	22.0	22.3	29.7	26.2	19.6	22.7
Average of rolled plots		15.1	17.6	17.3	18.3	17.8	16.1	17.0
Average of non-rolled plots		9.3	12.2	15.3	14.3	14.1	13.3	13.1
Average—all plots		13.4	16.1	16.7	17.2	16.7	15.3	15.9
Average spring plowing vs. not plowing			15.4			16.4		

TABLE 2. EFFECT OF VARIOUS ROLLING AND PLOWING TREATMENTS ON YIELD OF OATS

Plot No.	No. of times Rolled	Fall Plowed		Not Plowed		Spring Plowed	
		Grain Bu. per Acre	Straw Lbs. per Acre	Grain Bu. per Acre	Straw Lbs. per Acre	Grain Bu. per Acre	Straw Lbs. per Acre
1	Not rolled	22.0	2304	32.3	2080	15.5	1344
2	Once before planting	22.2	2176	30.5	1984	12.2	1312
3	Once before and once after planting	25.8	2432	29.8	2240	18.4	1472
4	Once after planting	25.4	2464	26.5	2048	19.0	1536
5	Not rolled	19.6	1760	31.7	1920	13.3	1280
6	Once before planting	20.5	2016	33.7	2400	15.8	1248
7	Not rolled	20.8	1728	28.4	1728	12.0	1408
8	Once before and once after planting	28.3	1888	33.4	2048	19.2	1664
Average of rolled plots		24.4	2195	30.8	2144	16.9	1446
Average of not-rolled plots		20.8	1931	30.8	1909	13.6	1344
Average—all plots		23.1	2096	30.8	2056	15.7	1408

TABLE 3. EFFECT OF VARIOUS ROLLING AND PLANTING TREATMENTS ON YIELD OF RYE

Plot No.	No. of times Rolled	Spring Rye—1922		Winter Rye—1923	
		Spring Plowed Bu. per Acre	Not Plowed Bu. per Acre	Fall Plowed Bu. per Acre	Not Plowed Bu. per Acre
1	Not rolled	2.6	6.8	16.3	22.5
2	Once before planting	4.3	5.4	17.0	22.1
3	Three times before planting	4.7	9.3	---	---
4	Once before and once after planting	9.8	12.3	21.4	22.8
5	Once after planting	10.0	8.2	*11.7	*16.5
6	Not rolled	8.7	8.9	*10.2	*16.0
7	Once before and once after planting	11.2	11.0	---	---
8	Once before planting	---	---	18.5	22.7
9	Not rolled	5.7	7.6	18.0	22.6
10	Once before, once after planting, twice during growth	3.5	7.8	---	---
11	Once before, once after planting, and once in spring	---	---	23.8	26.5
Average of rolled plots		7.3	9.0	20.2	23.5
Average of not-rolled plots		5.7	7.8	17.2	22.6
Average—all plots		6.7	8.5	19.1	23.2

WIND DAMAGE TO PEAT CROPS

Prevention of damage to peat soil crops from wind seems to become a greater problem from year to year and it is felt that operators on areas subject to high winds will be compelled to pay more attention to the protection of their crops from this element. The cutting away of forested areas, giving the wind an unobstructed sweep, especially in very level countries, is one of the chief causes of the destructive winds which cause so much damage to onions, mint, corn, cabbage, celery and other peat land crops. Another potent cause is too great lowering of the water table, or in other words, overdrainage, resulting in a very dry soil which is especially subject to wind action. Various plans have been successfully employed for the control of wind. Windbreaks consisting of tall growing trees planted around the fields are a great help. In some cases these are supplemented by hedges of privet or some other bushy plant spaced every two to three hundred feet through the field. In other cases strips of rye or some other crop are drilled at intervals through the field. Rolling to compact the soil, thereby improving the movement of soil water, is also practiced. In other cases the water table is raised by damming the ditches. Overhead irrigation is used, making it possible to keep the soil thoroughly wet, thereby preventing serious movement. The two pictures presented herewith show methods employed in some cases for wind control or at least for minimizing the damage from wind.

The following article discusses this problem in a comprehensive way. It is believed that it will be of interest to peat land owners who are confronted by this problem:

Prevention of Crop Injury by Windstorms on Muck Land*

A Discussion of the Use of Water, Heavy Rolling and Windbreaks in the Prevention of Crop Destruction by Winds on Muck Land

PAUL M. HARMER, Soils Section

The spring of 1925 was one of the most disastrous that has ever been experienced by the muck farmers of the state. The beginning was very favorable, permitting early planting, but the month of May was one of the driest, as well as the windiest, on record. With the surface of the muck very dry, frost, which occurred during the latter part of May, produced a much greater injury to the muck crops than would have been the case with normal rainfall. Mint was frozen to the ground; early cabbage, beets and celery were killed, and onion fields on the drier mucks seriously injured.

Crops were replanted and conditions looked better, when. on June 9, the greater part of Michigan, together with northern Indiana, Ohio and Illinois, was visited by a severe windstorm. This started shortly after 10 A. M. at Lansing and lasted the remainder of the day. Muck fields which were bearing cultivated crops were left as barren as if they had never been planted, and in some places even grain was carried away. Crops, weeds, fertilizer, and muck to a depth of three or four inches were swept to the nearest meadow, grain field, windbreak or ditch. In addition, some parts of the state were visited by a less severe windstorm on June 22, which undid some of the repair work done following the storm of June 9.

The extent of the windstorm of June 9 is evident from the fact that eight out of eleven of our experimental projects on onions were blown out, those in Huron, Gratiot, Newaygo, Barry, Lenawee, Eaton and Clinton counties being destroyed. Of the three sets that withstood the storm, one was protected on the west by a good growth of sweet clover, one was a very sandy muck and the third was saved by the thoughtfulness of the farmer, who piled onion crates along the west side of the plots to protect the crop.

During periods of normal rainfall, injury to a muck crop is generally due to cuts and bruises inflicted on the plant by the blowing particles. During the windstorm of June 9, however, an even

*Reprint from the Michigan Agricultural Experiment Station Quarterly Bulletin, November, 1925, Vol. 8, No. 2.

greater injury was produced by the removal of several inches of the dry muck. Onions were left hanging by the ends of their roots and their destruction was completed when the warm sun the following day dried the roots. Mint roots were either blown from the field or left lying exposed on the surface, where the winds soon dried them beyond recovery. Following the windstorm of June 22, the writer observed seed of late potatoes, which had been planted with a hand-planter, lying exposed on the surface of the muck, showing the removal of at least two inches of the surface soil.

Because of this severe wind injury to the crops during the past spring, farmers are now inquiring about the chances of a repetition of the occurrence. Mr. D. A. Seeley of the U. S. Weather Bureau at East Lansing, reports that the combined rainfall of May and June in the vicinity of Lansing was less during the present year than for the same two months of any year since 1864. He reports also that there is no record for the state showing a similar combination of drought and high winds, so conducive to crop destruction, as occurred during the past spring. Muck farmers of Huron county report an even more destructive wind, which completely destroyed their onion plantings, in 1901. Though there seems to be little chance of such recurrences in the near future, "muck storms," on many of our drier muck areas, often occur several times in a season. Furthermore, on all muck land the destruction by wind storms of many of the specialized crops and the removal of the top soil, even occasionally, is cause for consideration, and means of prevention of such possible loss is a good form of insurance.

Damage by wind to crops on muck land may be greatly lessened by three different means, viz.:

1. Maintenance of a good supply of moisture in soil.
2. Compaction of soil by heavy rolling.
3. Use of windbreaks.

The use of any one of these methods alone is often not sufficient. In fact, it is advisable, in a good system of muck farming, to employ all three methods.

Control of Moisture Supply

Maintenance of a good supply of moisture in a muck soil is necessary primarily for securing a good stand and good growth of the

crop planted, but its effect in preventing blowing of the muck is important. The moisture supply may be increased during a drought either by sub-irrigation or by overhead irrigation. The overhead system of irrigation gives very good results because when the surface

A combination of windbreaks and irrigation for wind and water control

of the muck is wet, it is not blown by the wind. Because of the expense in installing this system, its use must be limited to the more intensive truck crops, such as celery. Growers of this crop with this means of supplying moisture were very fortunate during the past spring, both in the protection of their seed beds and in the setting of their celery in the field. It is obvious that, along with the overhead irrigation it is necessary to have windbreaks to prevent injury from muck blown from neighboring fields.

Sub-irrigation for maintaining a supply of moisture in time of drought is better adapted to general farming and to mint and onion growing. It consists in the damming of the drainage ditches (1) or closing of tile, to back up the water and raise the water level in the soil. Its success depends entirely on a constant supply of water in the ditches in time of drought. If the muck is excessively drained, a dam, or system of dams, in the outlet ditch will be required. In

some localities water can be secured by the diversion of a creek, while in others it is possible to secure artesian wells which open into the ditches just above the dams.

Use of Heavy Roller

Heavy rolling of muck land compacts the soil and thus induces a better capillary movement of water. As a result the surface layer dries out less, and consequently does not blow as badly. Reports made by several farmers who are using concrete rollers (2) which weigh 600 pounds or more per foot of length, showed in all cases during the past spring less blowing of the rolled muck than of that not rolled. Heavy rolling is especially beneficial when used in connection with sub-irrigation, unless the muck is exceptionally heavy. Following heavy rolling, cultivation should be shallow.

Use of Windbreaks

The different types of windbreaks may be listed as follows:

1. Trees.
2. Board fences.
3. Cheese cloth covering.
4. Shrubbery.
5. General crops.

Windbreaks composed of trees have been by far the most important factor in reducing loss of crops during the past spring. On many muck farms, the only early crops remaining were those protected by mixed groves of ash, elm, maple, white cedar, tamarack or other trees, located on adjacent land which had not yet been cleared. On some farms, rows of trees planted along the line fences have proven very beneficial, Norway spruce, white cedar (arbor vitae), box elder, willow and Carolina poplar being most common. The last of these is a large tree but is said to be short-lived. A good windbreak can be secured with a combination of one row each of golden willow or box elder and of Norway spruce or arbor vitae. The golden

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(1) For information regarding the construction of a cheap type of dam for the larger drainage ditches see: May, 1925, issue of the Michigan Experiment Station Quarterly which may be secured by addressing R. S. Shaw, Director, East Lansing.

(2) For information regarding the construction of a concrete roller see: May, 1924, issue of the Michigan Experiment Station Quarterly which may be secured by addressing R. S. Shaw, Director, East Lansing.

willow and box elder are rapidly growing trees and in a short time give considerable protection, while the Norway spruce and arbor vitae, being long-lived evergreens, make an efficient windbreak in later years. Of the two, the spruce appears to make more rapid growth on muck land but the arbor vitae produces a denser windbreak.

There are two objections to the use of trees for windbreaks on muck land: first, the loss of considerable areas which might be utilized for crop production, and second, the time required for tree growth. On the larger muck farms, the first criticism is not import-

Privet hedges at right angles to the direction of prevailing winds for protecting peat crop

ant and the second unavoidable. On the small intensively farmed muck areas, however, both points are important. Here the solid board fence solves the problem. On small fields the height of this fence need not be more than three to five feet, and it should cover at least the side (usually west) of the field from which most of the windstorms come. By this means, injury from the muck brought from neighboring farms is avoided, and by other means damage from removal of muck within the field can be prevented.

The use of some cover, such as cheesecloth, for the protection of a muck crop from wind injury, is out of the question because of the

expense, except in the case of celery seedbeds. Many of the smaller growers have adopted the practice of surrounding the celery seed bed with a board fence, approximately one foot high, from side to side of which is suspended a cheese cloth sheet. Often this is fastened to a rod at one end so that the sheet can be rolled up in favorable weather. This protection is provided chiefly to prevent frost injury but has been found beneficial in muck storms.

Of the different shrubs used as windbreaks, two should be mentioned. New York muck farmers report the use of the black currant, and the Japanese (sometimes called California) privet, as efficient windbreaks. These are planted in rows at intervals across the field. Another crop which has proven fairly satisfactory on the more acid muck areas is the raspberry. With the exception of the privet, these shrubs have the advantage that, besides serving as a windbreak, they produce crops as well.

Three types of general crops have proven useful as windbreaks: hay, corn and grain. Of the hay crops, white blossomed biennial sweet clover should be placed first and alfalfa second. The place for these crops is along the ditch bank where their rapid growth in spring serves to smother weed growth and to prevent injury to crops for some distance in ordinary windstorms. On onion plots near East Lansing, sweet clover on the west prevented injury to the first 15 rows, with little injury to the next five rows, of onions, even from the violent windstorm of June 9. Alfalfa is not satisfactory for this purpose unless the muck is well drained.

Corn has been used as a windbreak in some of the smaller muck fields. The crop is planted in single rows at intervals across the field, the ears harvested in the fall and the stalks allowed to stand during the following summer.

Of the grain crops, rye is best suited to use as a windbreak. It has been found especially satisfactory for use with the onion crop. The field must be stalked out in the fall and the rye sown fairly early so that it will make a rapid growth in the spring. Sowing can be done with an ordinary garden seeder, the distance between rows depending on the sweep of the wind across the field. Rows should extend at right angles to the direction of the wind. One onion farmer recommends planting rye instead of every twentieth row of onions. This is probably close enough, except in places where wind injury is an almost annual occurrence. In some places strips

of three to six drill rows of rye may be required. Another muck farmer reports successful use of rye for the protection of new mint. On a portion of his field which blew badly, he sowed rye in the fall in rows the same distance apart that the mint was to be planted. In the spring the mint was planted between the rows of rye. In the case of both onions and mint, the rye should be cut before it has reached maturity in order to prevent a volunteer seeding the following year.

SOME RECENT PUBLICATIONS OF INTEREST TO MEMBERS OF THE SOCIETY

"PEAT ITS MANUFACTURE AND USES" recently published as the final report of the Peat Committee appointed jointly by the Governments of Canada and the Province of Ontario, by B. F. Haanel, who needs no introduction to those referring to the Journal is so extremely interesting that it has been thought best to present a review in this issue of the Journal.

Perhaps the most effective way to give the scope and purpose of the work is to quote the Foreword of the report by Mr. Alfred A. Cole, Chairman, Peat Committee. "The accompanying report, which has been prepared under direction of the Peat Committee, contains a presentation of the results of the investigation conducted, and the operations carried on by the Committee in pursuance of instructions received from Governments of the Dominion of Canada and the Province of Ontario, early in 1918.

The objective of the investigations, which were financed by the two governments, jointly, was to find, if possible, a practical working method, capable of commercial operation on a large scale, whereby our extensive peat deposits might be made available as an auxiliary source of fuel supply, especially in the central provinces of Ontario and Quebec, where shortage of domestic supply of fuel was most keenly felt.

As the result of a careful preliminary survey of methods of manufacturing peat fuel experimented with, or adopted with varying degree of success, in other countries, the Committee was convinced that the air dried machine-peat process was the only one that gave reasonable hope of success in attaining this objective, and that, therefore, the development of mechanical appliances to curtail labor requirements and reduce cost of production to the lowest possible limits, was an essential preliminary step toward the establishment of a peat fuel industry in Canada. This opinion has since been strongly confirmed by the findings of the British Fuel Research Board, and the conclusions arrived at by European investigators of prominence.

Part I of the Report deals with the character and qualities of peat as a raw material for the production of fuel, and the extent of the peat resources of Canada as defined by investigations which have been carried on for a number of years past by the Dominion Department of Mines. The development of methods of peat fuel manufacture is traced, and the more recent machines employed in the manufacture of air dried machine peat in Europe are described and illustrated.

The chapter in this section of the report on the dehydration of peat merits special attention. Numerous and costly failures have resulted from attempts to accomplish the dehydration of peat by what may be termed artificial methods, in contradistinction to the natural air drying process. A clear understanding of the negative character of the results obtained in such cases, and of the underlying principles involved, should prevent expenditure by investors in fruitless efforts, which through their failure might tend to discredit the peat industry in general.

The field operations of the Committee at Alfred, Ontario, the machines developed, and the findings and conclusions of the Committee in relation to the several matters involved in the investigation are comprised in Part II while Part III is devoted to special applications and uses of peat fuel, including a description of the experiments conducted in the carbonization of air dried peat fuel.

Since the establishment of a peat fuel industry will naturally raise the question of disposal of those areas of the peat bog not worked for fuel production as well as those from which the fuel peat in course of time removed, a chapter on agricultural uses of peat and peat lands has been included in this report. Reports of special investigations made are also contained in the appendices.

It will be evident from a perusal of the report that the efforts of the Committee have met with a gratifying measure of success, that the object of its appointment has been substantially attained, and that the prospect of the establishment of a peat fuel industry in Canada on a sound economic basis has been materially advanced. This is of special interest to the northern districts of Ontario and Quebec where wood and peat are the only available local sources of fuel supply, since the wood resources convenient to the populated sections are being rapidly depleted, and the development of

known peat deposits of good quality becomes constantly a more attractive proposition, and a matter of increasing concern to the community."

The 300 page volume is well illustrated showing the apparatus and equipment studied and used in the several years experiments reviewed in the publication. The whole work is of an excellent character and will no doubt serve as a mile stone of progress in our study of American peat resources.

The following quotations from the Report will serve to illustrate the more important conclusions of the Committee.

"1. The only methods or processes which can be economically employed for the manufacture of peat fuel are those employing air drying.

2. Climatic conditions in Ontario and Quebec (acute fuel area) are favorable for the manufacture of peat on account of moderate rainfall, long summer days, and comparatively high temperature.

3. The manufacture of air dried machine-peat fuel can be carried on in these provinces for 100 days, from the early part of May to the latter part of August. Continuous operation is impossible on account of the severe frost during winter months.

4. A peat bog should be drained only sufficiently to provide a firm surface for supporting machines, harvesting tracks, etc., and to provide a suitable area for spreading and drying the macerated peat.

5. The quality of the fuel produced on any bog during the working season is limited by the length of the working trench and the width of the drying-area available. The maximum width of the drying-area which can be utilized economically is limited by the maximum length of the portable belt conveyor which can be employed to the best advantage. The length of the portable belt conveyor is limited mechanically, and the maximum length appears to be about 800 feet.

6. The rate of drying of the macerated, spread peat is influenced by the thickness of the spread to a certain extent by the degree of maceration, and by weather conditions. The maximum thickness of the spread during the earlier portion of the season, and up to the end of June, is 6 inches. Thereafter the maximum thickness should not be more than 4½ to 5 inches.

7. Under the average weather conditions prevailing in the

provinces of Ontario and Quebec during the summer months, it is possible to obtain two complete spreadings of the drying area in each season.

8. The use of caterpillar aprons for supporting heavy machinery on the surface of a peat bog is far more efficient than the old method of supporting machines on rails and ties.

9. A swing hammer pulverizer is more efficient and satisfactory for carrying out the operation of maceration than the conventional types of macerators heretofore employed.

10. The portable belt conveyor designed and operated by the Peat Committee proved highly efficient.

11. Labour costs with the combined Anrep-Moore plant designed by the Peat Committee were reduced to a minimum in relation to the capacity and output of the machine.

12. The most expensive item in the manufacture of air dried machine-peat fuel is that of harvesting the dried peat. Mechanical appliances have been devised which effect important economies in the carrying out of the operations involved, but the actual picking up of the fuel from the drying ground must still be accomplished by manual labor.

13. The total cost of a ton of peat fuel is greatly influenced by the over head costs, and successful commercial operations are, therefore, dependent largely on strict business management.

14. The peat fuel produced by the Committee at Alfred was of good quality, and was suitable for domestic, industrial, and other purposes.

15. The fines produced in screening the fuel before loading on cars for shipment are not to be considered as a waste product, snice they are of value for use in the manufacture of commercial fertilizers and for other purposes, and may, according to market conditions, command prices equal to or even higher than that of the fuel itself.

16. Owing to the high cost of transportation the limit to which peat can be shipped to advantage, under present freight tariffs, is approximately 100 miles.

17. Peat is a most admirable fuel for utilization in producer gas plants, either of the non-by-product recovery, or of by-product

recovery types, and is also suitable for steam-raising when the cost is low enough to permit the fuel to be used in competition with coal.

18. The commercial production of peat fuel on a large scale can be conducted on many of the bogs which have been examined in detail, and which are favorably situated with regard to inhabited communities and transportation facilities.

BULLETIN 253 OF THE U. S. BUREAU OF MINES, Department of Commerce, by W: W. Odell and O. P. Hood, entitled "Possibilities for the Commercial Utilization of Peat," issued recently, is another publication which is of great interest to all persons engaged in the utilization of peat for industrial or agricultural purposes. The work is of broad scope, covering peat fuel and its various methods of preparation and use, peat as a soil conditioner or as a fertilizer, peat litter, agricultural uses and various special applications.

The following extracts from the summary and conclusions of the bulletin will serve to illustrate some of the more important results given in this publication. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., the price being 35 cents per copy.

"Workable peat deposits of various grades under widely varying conditions cover a large area of the United States. * * * Peat is seldom the same from the top to the bottom of any particular deposit; it is usually stratified, the more mature and darker peat occurring at the lower levels, and the younger, less mature, lighter, fibrous peat at the upper levels. These deposits are found at the surface in varying thicknesses, usually 4 to 15 feet deep, and they may be entirely submerged with or without ready means for drainage, partly submerged, or entirely above the water table level; they may contain a large quantity of tree trunks and roots and be overgrown with forest growth, or they may be almost free from either. Likewise climatic conditions in peat-bearing regions vary widely, as exemplified in Florida and Minnesota. These facts coupled with the fact that the content of mineral matter—usually determined as ash—runs from a few per cent to more than 50 per cent of the dry peat, lead the authors to conclude that the general utilization of peat resources will depend

upon more than one usage for peat; indeed, such utilization will probably depend upon the finding of numerous industrial uses for peat."

"Manufactured products which might be made to a limited extent from peat on a commercial basis, under definite conditions, partiuclarly after a careful study of the particular process involved, are:

1. Peat fuel:

   (a) Domestic fuel.
   (b) Special fuel for certain furnaces and for certain metallurgical processes.
   (c) Generator fuel for manufacturing carbureted water gas in especially designed generators.
   (d) Dense charcoal suitable for the manufacture of charcoal iron or for domestic use.

2. Heat insulating material, including insulating board and molded insulation, wallboard, millboard, and similar products.

3. A substitute for wood and wood products for certain particular purposes.

4. Filler for molded plastics as a substitute for wood flour.

5. Absorbent cotton for filtration and clarification of liquids and for absorption of gases such as gasoline from natural gas, etc.

6. Miscellaneous minor products, such as packing materials, absorbents, deodorizers, etc."

"Artificial drying of peat—drying by the application of heat from the combustion of fuel—for use as a fuel is not an economic procedure, and should not be considered in this connection. The best method of winning peat, when a dense fuel is desired, consists in excavating the peat from the bog, macerating the wet peat, and spreading the macerated mass upon the ground or upon racks in thin layers to dry by exposure to the atmosphere."

"No manufacturing plants are producing peat fuel on a commercial basis in this country, so far as the authors know. Numerous attempts have been made to do so, but failure has attended every

attempt. Most of these enterprises have failed because the finished product (fuel) could not be produced cheaply enough to compete with other high grade fuels. * * * "

"Although some peats contain a relatively high percentage of nitrogen (N)—as high as 3 per cent or more—this does not signify that peat is a natural fertilizer. Contrary to the popular belief, peat is not a fertilizer, and the nitrogen present is not rapidly given up as plant food like the 'soluble nitrogen' of artificial fertilizer. Peat contains a large percentage of humic matter and is an excellent soil conditioner when used in large enough quantities. In this capacity it may so increase the productivity of the soil that it might be likened to a fertilizer, nevertheless it does not function in the same manner as fertilizer, and may be itself quite devoid of certain necessary elements of plant food.

"Peat is now being successfully used as a soil conditioner and is sold under the name 'humus.' To a limited extent it is used as a fertilizer filler, but the yearly proportion of peat is not increasing at the same rate as the production of artificial fertilizer. In fact, the production of peat and peat products is at a 'standstill'; there has not been any appreciable increase in a number of years."

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